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*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

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The Unity of Science and Religion.

THE Cardiff meeting of the British Association will be marked with a red stone in the road of progress because of two noteworthy events. One was the suggestion of the president, Prof. W. A. Herdman, eagerly taken up by members of the Association, that the time had come for a new *Challenger* expedition for the exploration of the oceans, and another was the enlightened sermon, which we print in full elsewhere, delivered by Canon E. W. Barnes, a distinguished mathematician who is both a fellow of the Royal Society and a Canon of Westminster. We do not hesitate to say that not for a long time has such a conciliatory attitude been presented to men of science by a leader in the Church as is represented by Canon Barnes's address. The position taken up in it is one upon which the two standards of science and religion can be placed side by side to display to the world their unity of purpose. For Science and Religion are twin sisters, each studying her own sacred book of God and building a structure which remains sure only when established upon the foundation of truth.

The day of bitter controversy between dogmatic theology and often no less dogmatic science is, we hope and believe, past and gone, and no one would wish to recall it. We certainly have no intention of opening a discussion in our columns upon Biblical interpretation or the bearing of scientific discovery upon it. The complete story of the struggle through which the present position has been gained is told by Dr. A. W. White in his "History of the Warfare of Science with Theology in Christendom," published last year. It is difficult now to realise what was done to pour contempt upon Darwin's works and discredit him and his followers by theologians of all types; but towards the end of the conflict it became clear that leaders in all Churches were beginning to understand that men could be Christians and at the same time Darwinians, and in latter days they have not only relinquished the struggle against science, but have also frankly shown their willingness to make an alliance with it.

Canon J. M. Wilson, another distinguished mathematician who has also the highest credentials to represent the views of thoughtful Churchmen, referred to this change of attitude in an article contributed to our Jubilee issue in November last. He then wrote: "Insensibly a change has occurred which is not easy to define. Perhaps it may be described broadly as the discovery by the scientific world that the sphere of religion is not inherently anti-rational; that faith, like knowledge, rests ultimately on experience; that science has its sphere in the world of matter leading up to forces of unknown origin and nature; and that faith has its sphere in a world of personality leading up to a similarly unknown goal of personality: that their methods are not inconsistent; and that their goals may be identical."

Religion cannot, in fact, afford to ignore what is true, and can have no real interest in believing what is not true. We have passed the dangerous stage when apologists strained analogies to prove that science and orthodox Christianity, so far from being in conflict, are really in perfectly amicable agreement, and have reached a point at which it is understood that science and religion both contain systems of truth which must ultimately prove to be congruent. Theological beliefs no longer rest solely upon the ancient foundation of authority, but are built upon a basis of reason. Just as every event in Nature is a manifestation of natural law or principle, known or unknown, so religion is natural and not supernatural, and the conceptions to which it leads may be submitted to similar inquiry. It is not a simple phenomenon, but a complex of thought and emotion, and the components of this complex have yet to be resolved.

The insufficiency of human life itself as an end is dealt with philosophically by Prof. Boutroux in his "Science and Religion in Contemporary Philosophy," in which it is urged that the ideal of duty summons us beyond the specifically human to a noble struggle and a great hope, an ideal which implies faith and love, and demands divinity and a Being with Whom we can be in communion. It is in the "living reason" interpreted in the light of duty that science, without which we cannot live, and religion, without which we do not wish to live, find their reconciliation.

The scientific view of religion, now accepted by men of science and Churchmen alike, is that religion is the spiritual life of the individual, and subject to development. Progress is possible here as elsewhere, and in fact the history of the forms of religion shows a gradual purification and emancipation advancing with the gradual refinement of experience. The goal, as a reviewer has said in these columns, is a union of God and humanity, and the end must be the concrete realisation of unity in life and purpose for which, as for the unity of the world as object of the sciences, the reality of the Divine immanence is the only sure ground.

The origin of religion itself is still obscure. Whether it arose from belief in spiritual beings, in the worship of the soul, in ancestor worship, in ghost propitiation, or in any other of the various views which have been put forward, has yet to be decided. The system of social morality early developed when primitive communities were formed by man has little to do with religious perceptions. It is easy to pass, however, from the stage of veneration for great heroes or benefactors during life to that of ancestor worship after death, and later to soul worship. There would be sainted dead to worship, as well as malevolent dead and spirits of disease to propitiate. Eventually might arise the philosophic conception that continuation of life lies, not in the immortality of the soul, but in the perpetual remembrance of the righteous by mankind. All these matters are legitimate subjects of inquiry, and men of science may join with theologians in elucidating them. The problems are difficult, but not beyond solution, and they are approached to-day in a less dogmatic spirit than they were a few years ago by advocates on both sides. As regards the true relations between soul and body, we are in much the same position as that of the Persian poet who wrote long ago:—

> There was a Door to which I found no Key;
> There was a Veil past which I could not see.

Whatever the end may be, we are urged to the quest by that something within ourselves which has produced from a primitive ancestry the noblest types of intellectual man, and regards evolution, not as a finite, but as an infinite, process of development of spiritual as well as of physical life.

The Drying Up of South Africa—and the Remedy.

The Kalahari or Thirstland Redemption. By Prof. E. H. L. Schwarz. Pp. vi+163+xiv plates. (Cape Town: T. Maskew Miller; Oxford: B. H. Blackwell, n.d.) Price 8*s*. 6*d*. net.

WHILST Man of all races and skin-colours is once more involved in fratricidal quarrels—*how* Superior Intelligences in more advanced spheres must grin as they watch our wars against one another through super-telescopes or by æthereal telegraphy!—Nature is making one more effort to get rid of man. This time through Drought. She has seemingly hated everything that rose above the mediocre on this planet, whether it was in fish shape, or in the fish-saurian, the dinosaur, the struthious bird, the ungulate mammal, or the brain-worker, Man. She tried to nip us in the bud by reviving the Ice ages which she had used for other destructive purposes in the pre-Cambrian, Devonian, Permian, and Jurassic periods. But this succession of cold spells only braced Northern Man to greater efforts and greater triumphs, and sent Southern Man to grapple with the tropics, and to digest and partly overcome their germ diseases. Now the tropics, and above all the sub-tropical regions, are being threatened by drought. The desert is spreading in sub-tropical North America, in tropical South America, in temperate and sub-tropical Asia and eastern Europe, in northern and north-central Africa, and in that prolongation of the African continent which lies beyond the Zambezi and Kunene Rivers.

Prof. Schwarz theorises on the earlier theories of others—British, South African, French, and German—and propounds explanations and suggests remedies derived from his own geographical and geological investigations in South and South-west Africa; and the result is an exceedingly interesting little book, well illustrated and well worth the modest price asked for it—though insufficiently served by its maps. He points out that the main cause of the creation—the recent creation—of the Sahara, Libyan, and Kalahari deserts in Africa has been the diversion of river courses, most of which ran (more or less) from south to north and north to south, but now reach the sea by shorter courses almost at right angles to their former direction.

At no great distance in time it is highly probable that the Kunene River of southern Angola had made no breach in the western rock rampart of the Ovambo plain; it flowed instead by several dried-up water-courses into the Etosha lake, and thence along the Ovambo River to the Omatako and the Kalahari plain. Joined further by the waters of the Kwito, Okavango, and Kwando, this accumulated drainage of the lofty plateau of eastern Angola emptied itself, not—as now—into the Atlantic or the Zambezi, but into a huge expanse of water of which Lake Ngami and the Makarikari "depression" and salt pans are the shrunken remnants. Finally, in all probability this great lake of South-west Africa found an outlet through the Molopo River of western Bechuanaland into the Orange, and so at last reached the sea. But its moisture, through the soil and the atmosphere, rendered the western half of South Africa a fertile land endowed with exuberant vegetation and animal life, and able to support a large human population.

The author shows in this book how by engineering operations less difficult, probably, than those which have tripled the value of the Nile waters, the Kunene and Okavango and their tributaries might once more be diverted into the old channels and restore to human use and benefit an area of more than a million square miles. His schemes and plans will, of course, be riddled by the same "expert" criticism which declared the Suez Canal an impossibility, or be side-tracked through some political jealousy. But, all the same, if something more or less in the nature of his proposals is not soon put in hand, the habitable area of trans-Zambezian Africa will shrink considerably.

Man must give up internecine warfare and unite all his forces to defeat his arch-enemy, Nature. He must melt the ice at the North and South Poles, and put a stop to the spread of desert conditions in Asia, Africa, Australia, and the Americas. H. H. JOHNSTON.

Cement Manufacture and Testing.

Cement. By Bertram Blount. Assisted by William H. Woodcock and Henry J. Gillett. (Monographs on Industrial Chemistry.) Pp. xii+284. (London: Longmans, Green, and Co., 1920.) Price 18*s*. net.

THE need for a handy text-book on cement, which should include the modern processes of manufacture and also a review of the chemical aspects of the subject, has been felt for some time, and this work of Mr. Blount should go far towards meeting the requirements. The author has an extensive practical experience of cement manufacture and testing, and is accustomed to present accounts of the industrial processes in a readable form. With the exception of a few passages, the work is devoted to Portland cement, and the processes of manufacture selected for description are almost exclusively those which are adopted in England. Rather fuller references to Continental and American methods would have been welcome, since those methods, almost similar in principle, present great differences of practical detail.

The use of blast-furnace slag as a raw material for the manufacture of Portland cement receives only the briefest mention, but this is now extensively practised, and the product is likely to play an important part in building and engineering operations in such regions as the North of England and Scotland, where suitable clays or marls are rare, whilst slag is a waste by-product of the iron industry. The further use of finely ground slag as a pozzolanic material is not noticed, and, indeed, the whole subject of pozzolanas deserves more attention. It is not sufficiently recognised that the lime set free during the setting of Portland cement, like the slaked lime of an ordinary mortar, is capable of combining with silica when presented to it in a sufficiently active form, and that even a good cement may be considerably improved by the addition of a suitable pozzolanic substance. White Portland cement made from raw materials exceptionally free from iron is not mentioned, but its manufacture is of some interest, and has been conducted with success on a technical scale.

The account of the consumption of energy in grinding is not quite correct. It is not true of most minerals that the energy required to separate crystals along their cleavages is very small, and clinker, although it may be in a state of internal strain, nevertheless possesses a degree of hardness which requires great energy to disintegrate it, as may be shown by applying direct pressure to single granules of clinker in a testing machine. There are several suggestive notes regarding possible improvements in the manufacturing processes. The author has long argued that the logical goal of improved manufacture should be the production of such a high temperature as will yield a fused product, in which case a higher percentage of lime could be used and a homogeneous cement obtained. Certain improvements in regard to fuel economy and to the recovery of potash are also suggested.

On the subjects of chemical analysis and mechanical testing the author speaks with authority, and the chapters dealing with these sections may safely be used as a laboratory guide, whilst their usefulness is enhanced by the inclusion of a number of the more important official specifications for Portland cement in force in various countries. The fact is mentioned that "a cement which will pass the British standard specification is at least as good as that acceptable under any of the foreign specifications."

The vexed question of the chemistry of Portland cement is well treated, but a good deal of space is occupied by an account of researches and speculations which have no more than an historical interest. It is not so widely known as it should be that the whole chemistry of silicates has been revolutionised by the brilliant work emanating from the Geophysical Laboratory at Washington, which has replaced guesswork by an accurate physico-chemical survey of the systems concerned. The triangular equilibrium diagram of the lime-silica-alumina system is now known with sufficient accuracy to serve as a practical guide in the cement laboratory. The study of setting, on the other hand, has not advanced very greatly beyond the stage reached by Le Chatelier. The author, in referring to the work of Stern, has overlooked the fact that the examination of clinker and cement by reflected light after etching has been used successfully by several workers, and that excellent photographs of the fine eutectic structures have been published, some of them in Japan.

These points might well receive attention in a future edition, and would still further increase the value of a very useful book.

C. H. DESCH.

Psychology, Normal and Subnormal.

(1) *Psychology of the Normal and the Subnormal.* By Dr. H. H. Goddard. Pp. xxiv + 349. (London: Kegan Paul, Trench, Trubner, and Co., Ltd., 1919.) Price 25s. net.

(2) *Psychology and the Day's Work: A Study in the Application of Psychology to Daily Life.* By Prof. E. J. Swift. Pp. ix + 388. (London: George Allen and Unwin, Ltd., 1918.) Price 10s. 6d. net.

(3) *The Child's Unconscious Mind: The Relations of Psychoanalysis to Education: A Book for Teachers and Parents.* By Dr. Wilfrid Lay. Pp. vii + 329. (London: Kegan Paul, Trench, Trubner, and Co., Ltd., 1919.) Price 10s. net.

UNTIL the last half-century psychology was based almost exclusively upon the observation of a highly intelligent and highly civilised type of mind—usually the mind of the psychologist himself. Modern psychology owes its remarkable progress chiefly to two factors: first, to the addition of the method of experiment to the method of observation; and secondly—a factor the importance of which is less generally recognised—to the extension of these two methods to the study of simpler types of minds—of the minds of animals, of children, of savages, and of abnormal adults. The recent increase in the number of institutions for feeble-minded children has now provided psychology with the simplest human material available for investigation. Just as the ultra-rapid camera slows down the kinematographic picture of the swift movements of leaping and running, so Nature, by an arrest of the brain, retards the normal development of the child so that it can be observed and tested at leisure.

(1) The laboratory attached to the Vineland School for Feeble-minded Children—a laboratory unique of its kind, not only in America, but also in the world—has been utilised for such studies since 1906. Dr. Goddard's book provides a popular *résumé* of the conclusions progressively accumulated by the investigators in that laboratory. It is not a psychology merely of the mentally defective child. It is a psychology of the normal human mind as illuminated and illustrated by the observations upon the mentally defective. The volume, however, is by no means confined to observations carried out at Vineland. Indeed,

these are all too modestly alluded to. The exposition incorporates, in a clear and for the most part non-technical form, much of the most recent work done elsewhere upon the obscurer functions of the nervous system and of the mind.

The first two chapters give a simple but up-to-date account of the nervous system, admirably illustrated by nearly forty diagrams and photographs. Due emphasis is laid upon the importance attached by recent studies to the part played in the formation of mind and temperament by the activities of the "sympathetic" portion of the nervous system. Mental deficiency is then treated; it is described as an arrest in the development of intelligence, due to an arrest in the development of the nervous system at or before twelve years of age—that is, at some period before the onset of puberty. Memory, attention, and association are discussed in turn, and considered primarily as properties inherent in the nervous mechanism. The higher mental processes—action voluntary and involuntary, language, and (to adopt the author's spelling) "thot"—are then discussed as the complex results of the interaction of the fundamental properties of the nervous system. The affective side of experience—the emotions, simple and complex, and that elusive quality called temperament—receive full attention; and a lucid exposition is given of the views more particularly of Mosso, Cannon, and McDougall. To the results of psycho-analysis no reference whatever is made.

The first half of the book is thus an exposition of psychology from a physiological point of view. The second part proceeds to apply the views so expounded to certain theoretical and practical problems. A brief account is given of the distribution of intelligence, of its diagnosis by means of mental tests, of its relations to will, and to emotion. The book concludes with two chapters embodying applications of the results achieved to questions of scholastic and moral training.

(2) Prof. Swift's book consists of a series of popular essays upon the psychology of daily life. It is not a systematic survey of the whole field of mental hygiene. Rather the choice of subjects has been determined, as the preface acknowledges, by the author's personal interests. It includes, however, several important topics upon which recent investigation has thrown great light—topics which are closely related to everyday problems, although the relation has not always been recognised: for example, the psychical aspect of matters commonly considered to be primarily physiological, such as digestion, fatigue, and biological adaptation. There are also chapters upon matters the psychological and practical aspects of which are alike better recognised—testimony and rumour, memory-training, habit-formation, and learning generally. Illustrative material is drawn not only from the latest researches, but also from a wide reading of fiction, biography, and general literature. A couple of papers are inserted upon problems connected with unconscious processes of the mind, such as multiple personality and the curiosities of recollection. But here the point of view and the data are not always quite up-to-date.

(3) In the two foregoing books Dr. Goddard and Prof. Swift scrupulously avoid all mention of psycho-analytical doctrines. Dr. Lay's book barely refers to any others. His chapters attempt an interesting and even urgent task. The recent work of the psycho-analytic school has emphasised the important part played by unconscious tendencies in the formation of human personality. The simpler of these tendencies appear to be inherited, much as instincts are inherited by lower animals, and first emerge during the immature period we term childhood. The more complex are acquired through experience after birth; but even these are largely built up during the first few years of life. It follows that parents and teachers who view their task as comprising not merely the education of the intellect, but also the training of the character, should be instructed in the nature and properties of these unconscious tendencies, since, just because they are unconscious, they are so easily overlooked and so subtly persistent. The application, therefore, to educational problems of the better-established facts and principles embodied in the doctrines of psycho-analysis constitutes a fruitful field of discussion.

In his book Dr. Lay has set himself to attack this field. Twenty years of teaching in a secondary school, he tells us, has convinced him that "the modes of thinking on the part of children are irremediably (without the teacher's knowing of the effects of the unconscious) twisted, and that they are so by virtue of their numerous complexes." Unfortunately, Dr. Lay's own mode of thinking is apt at times to become, like his sentences, itself a little involved; and one may venture to doubt whether the teacher or the parent whose first introduction to psycho-analysis is obtained from the present volume will reach a very clear conception of the nature or the value of the new doctrines. He is required to think in very technical terms—of "*libido*," its "displacement," its "transference," and its "sublimation," of "identification" and its two forms of "projection" and "introjection," of "censorship" and "resistances" and "ambivalences" and "compensations." And for all these concepts very little empirical evidence is adduced.

Dr. Lay's method of demonstration inclines, too, almost exclusively to an *a priori* form: "*It is inconceivable* that all the sights, sounds, and other impressions we have had should not have an effect upon each other and so upon our present constitution . . ."; "*It seems in every way more rational to suppose* that conscious and unconscious thought and action are causally connected in both directions. . . ." This is scarcely the soundest type of scientific reasoning. Apart from a casual reference to William James (who incurs Dr. Lay's censure because he devoted to the sex-instinct only one page out of a thousand), pre-Freudian psychology is almost entirely ignored. That Ward and Stout and McDougall had constantly emphasised the importance of unconscious dispositions; that James, McDougall, and Shand had elaborated a widely accepted theory of instincts and emotions as the true basis of character; that the part played by conflict and repression in the formation of character had been succinctly stated by Stout; that the formation of a sentiment of maternal love has been described by Shand and McDougall in terms almost the same as Freud and Jung have used to describe the formation of parental complexes; that the nature and development of the sex-instinct had been closely studied by Stanley Hall and Havelock Ellis—of this the lay parent and the lay teacher learn nothing. Nor would they gather that for knowledge of the nature of the child's unconscious processes, of his complexes, his repressions, and his fantasies, the psycho-analyst is still almost entirely dependent upon the results gained by analysing the minds of abnormal adults, and can scarcely quote more than tiny fragments of first-hand observation made upon young and normal children. The psycho-analyst will perhaps contend that the earlier writers did not grasp the profound and all-pervading significance of the facts they partly formulated. But it is scarcely fair to suggest that upon such problems, before the new era of Freud had dawned, "no really scientific observations had been made." This is not the attitude or the method of Freud himself.

Yet, despite his shortcomings as a man of science and as a psychologist, Dr. Lay, as a practical teacher, has interspersed his somewhat diffuse and theoretical disquisitions with many shrewd observations upon child life, with many suggestive deductions from his master's principles, and with many opportune recommendations for home-training and for class-room procedure.

Three Philosophers.

(1) *Aristotle.* By Dr. A. E. Taylor. Revised edition. (The People's Books.) Pp. 126. (London and Edinburgh: T. C. and E. C. Jack, Ltd.; T. Nelson and Sons, Ltd., 1919.) Price 1*s.* 3*d.* net.

(2) *Auguste Comte.* By F. J. Gould. (Life-stories of Famous Men.) Pp. v+122. (London: Watts and Co., 1920.) Price 3*s.* 6*d.* net.

(3) *Thomas Henry Huxley: A Character Sketch.* By Dr. Leonard Huxley. (Life-stories of Famous Men.) Pp. vii+120. (London: Watts and Co., 1920.) Price 3*s.* 6*d.* net.

AT a time when constitutions are in process of adoption for so many unfamiliar areas on the map, it seems singularly appropriate that some attention should be diverted from such modern problems as relativity and Bolshevism to the older struggles and the ideas to which they gave rise. An excellent opportunity is provided by the three books under notice.

(1) Dr. Taylor's "Aristotle" is not quite in the same class as the others, for Aristotle's life occupies but little space. The author directs attention to the debt we owe to "the Stagyrite" for many of the commonest ideas in our language, and his avowed object is "to help the English reader to a better understanding of such familiar language and a fuller understanding of much that he will find in Dante, Shakespeare, Bacon, and Milton." It is a pity that he has not managed to avoid the frequent use of "logical" terms, probably unintelligible to those whose education has been merely commercial. It is possible that this usage has been deliberate, in order to support Aristotle's contention that a curriculum which includes only "useful" subjects does not constitute education at all—a doctrine that has not yet lost all its supporters. The book gives a fairly comprehensive sketch of Aristotle's progression, from "first philosophy" to physics, and on to practical philosophy—*i.e.* ethics and politics. It is interesting to recall that Aristotle objected equally to democracy and to oligarchy as understood by the Greeks, so that his ideal State would scarcely find favour with many of our present-day politicians. Dr. Taylor is impartial in dealing with points of difference between Aristotle and his quondam teacher Plato, but he does little to help to account for the ascendancy of Aristotle for so many centuries.

(2) It is a far cry from Aristotle to the nineteenth century, though we may regard many of the old Greeks, in spite of their mythology, as rationalists in much the same sense as Comte, though perhaps

not in the same degree. Comte's biography is the work of a professed disciple, but he seems unable to make the apostle of "Humanity" a sympathetic figure. There is a feeling of something lacking in the book in this respect. There is no evidence that it is intended only for the elect, and the ordinary reader may easily be repelled, even if he belongs to the class, so generally miscalled the proletariat, to whom Comte expected his social philosophy to appeal most powerfully. His Positivism certainly made a great impression on those of the working class who attended his free lectures on astronomy, the first science to become "positive" in Comte's view. The Positivist calendar, given as an appendix, is interesting, though to the general reader many of the names are quite unknown.

(3) This book is a really fascinating character-sketch of Huxley by his son, and the great "agnostic" stands out a vivid, rugged, but very sympathetic figure, an honest seeker after truth, a resolute opponent of "dogma." We meet also the outstanding personalities of his contemporaries, Darwin, with Hooker, Tyndall, and other members of the famous X Club. Had the question arisen forty or fifty years earlier, what would we not have given to be present at a symposium debating Einstein's theory of relativity? Huxley's indictment of "the Church" is as thorough as his championship of Darwin, and might be unanswerable could we altogether ignore the limitations of the human intellect. His logical conclusion that his views precluded the hope of future rewards as well as the fear of future punishments enforced on him the duty of living the most upright of lives, and Sir S. Walpole could not have been by any means the only one to endorse the verdict of the little girl who emphatically declared: "I think Prof. Huxley is the best man I have ever known."

W. W. B.

Our Bookshelf.

The Dyeing Industry. Being a third edition of *Dyeing in Germany and America.* By S. H. Higgins. Pp. viii+189. (Manchester: At the University Press; London: Longmans, Green, and Co., 1919.) Price 8*s.* 6*d.* net.

In the first edition of Mr. Higgins's book (NATURE, November 7, 1907, p. 4) the subject-matter presented was mainly novel in character, giving, as it did, the author's impression of the state of development of the dyeing industry in Germany, Austria, and the United States. A second edition was issued during the war period (NATURE, June 4, 1917, p. 303), and the present notice refers to a third edition.

It is gratifying to find such a steady demand for technical literature, which presumably arises from new readers, but the revised title of the book, "The Dyeing Industry," may lead such to look for a systematic treatment of the various aspects of the industry. This is not attempted in the book, the only new features of which are the inclusion of some of the author's recent valuable contributions to current literature and an extension of the section dealing with the manufacture of dyestuffs—which, by the way, is a quite distinct industry.

It is to be hoped that the author will find an opportunity of producing a book dealing with the dyeing industry of the present day, since information gathered so long ago as 1907 is unlikely now to represent the position with regard to such a rapidly developing scientific industry as dyeing.

W. M. G.

A Handbook of British Mosquitoes. By Dr. William Dickson Lang. Pp. vii+125+5 plates. (London: British Museum (Natural History), 1920.) Price 20*s.*

DR. LANG'S work makes it possible to determine with comparative ease most, if not all, British mosquitoes, including, so far as they are known, the larvæ in their various instars. The book consists mainly of three sections—(1) Introductory; (2) Identification; and (3) Systematic Account. In the introductory section are given the characters by which mosquitoes may be distinguished from gnat-like flies, a general account of the life-history, and such discussion of the morphology of the adults and larvæ as is necessary for purposes of identification. The second section is treated in an eminently practical manner, and the interpretation of the directions, lucid themselves, is rendered simple by the numerous excellent illustrations. In the third section the taxonomic aspect is considered, and our knowledge of each species summarised.

Dr. Lang's work will prove of great value to all interested in mosquitoes, and particularly to those who find the existing monographs on these insects too technical or involved. It gives a clear insight into the characters used in distinguishing these insects and their larvæ, but it must be remembered that the value of some of the points used, although great in separating the British species, is really exaggerated, and, therefore, neither they nor the sequence of instructions can be rigidly applied to foreign mosquitoes.

Volumetric Analysis. By J. B. Coppock. Second edition, revised and enlarged. Pp. 100. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) Price 3*s.* 6*d.* net.

THOUGH this volume has no special features to distinguish it from others of a similar type, it should prove useful to elementary students of chemistry preparing for examinations of Intermediate B.Sc. standard.

C

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Colour of the Night Sky.

So far as I have been able to learn, little or nothing is known about the colour of the night sky. The light is too faint for ordinary visual discrimination of colour, which disappears with diminishing intensity of illumination much before the light itself ceases to be perceptible.

I have obtained evidence, both visual and photographic, that the clear sky at night is much yellower or less blue than the clear, or even the cloudy, sky at twilight.

The visual observations were made in the following way:—Two gelatine films were prepared, one dyed yellow with flavazine and the other with methylene-blue, the relative intensities being adjusted by trial to give the effects that will presently be described. The films were mounted edge to edge at the end of a pasteboard tube, which was pointed at the sky. During the daytime the yellow film was confidently pronounced by all observers to be the brightest, the difference being too marked to be embarrassed by colour difference. As twilight advanced the Purkinje phenomenon came into evidence, and the blue film became much the brighter. This remained the case when the light had waned so far that the colour sensation had disappeared. As the stars came out the predominance of the blue became less marked, and before the Milky Way was distinguished there was equality. Finally, when the Milky Way was conspicuous the yellow film was notably the brighter, whether the tube was pointed to the Milky Way or to other parts of the sky.

The changes described were very marked. Their general course was the same whether the sky was clear or cloudy at any particular stage. The first change, when blue becomes predominant, is due solely to physiological causes. But the second change, which makes the yellow predominant again, occurs below the "threshold" of colour-vision, and, according to received views, there should be no marked complication from physiological causes within this range. Accordingly we may conclude that the observation affords definite evidence that the night sky is yellower or less blue than the day sky.

This conclusion has been confirmed photographically. A yellow and a dense blue filter were selected, and an Ilford panchromatic plate was exposed to the sky under these. It was seen at a glance that the density under the blue filter was the greater for the twilight sky, while for the night sky this relation was reversed.

The results point to the conclusion that the light of the night sky, whatever the cause of it may be, is not due to the scattering of sunlight by rarefied gas situated beyond the earth's shadow. The comparative absence of polarisation, formerly found, points to the same conclusion. RAYLEIGH.

Beaufront Castle, Hexham, August 20.

University Grants.

THE article and letters in NATURE upon the subject of university finance are very timely. It is essential that the country should be alive to the perilous condition of the universities from a financial point of view.

The raising of fees that has just taken place can be only a partial remedy. Fee revenue before the war provided at the various universities at the most for 40 per cent. of the necessary expenditure, the average being about 33 per cent. The recent increase in fees will barely re-establish the pre-war percentage.

I agree with the Principal of Birmingham University that the stipends of the non-professorial staffs must be increased; the urgency is not less great for the salaries of the professorial staffs. In London the utmost that has been done for the professorial staff is to increase the minimum full-time salary from 600*l.* to 800*l.*

Now the majority of the London professors receive the minimum. Considering the responsibilities of a university professor, what is 800*l.* a year for a man in that position under present conditions? Such a prospect will not induce young men of the right calibre to make university teaching their profession.

It is true that the Government has made non-recurring grants to pay off war losses, and for the time being doubled the grants. Having regard to the condition of the National Exchequer, the Government has perhaps done as much as could be expected for the current year. The all-important question for the universities is: What is the Government going to do next year?

It must be remembered that the maintenance grants are made for periods of five years, and are then revised. Revision was due in 1915, but was impossible during the war. The period 1910–15 had been one of unusual activity and development in all the universities. It was the general expectation in 1914 that the grant for the quinquennium 1910–15 would be doubled for the period 1915–20. By doubling the 1910–15 grant now the Government has done no more than redress the disadvantage due to the depreciation in the value of money.

Having that in mind, the deputation of Vice-Chancellors and Principals in 1919 impressed on the President of the Board of Education and the Chancellor of the Exchequer that the smallest grant that would meet the needs of the moment would be the 1910–15 grant quadrupled. That will do no more than enable the universities to carry on; it will not provide the capital necessary for new buildings, new plant, and equipment, nor will it enable justice to be done to the older men who bore the heat and burden of the day of pioneer work before the time of the establishment of superannuation funds.

There are many such men due to retire in the next few years; they are entitled to treatment at least as generous as that given to schoolmasters by the Fisher Act. GREGORY FOSTER.

University of London, University College, August 23.

THE only elements of our society which seem to benefit from the great increase in the wealth of the world through science are those which it will be one of the hardest problems of reconstruction to divert into more productive and honourable means of livelihood. Those who sow the seed and reap the harvest alike, year by year, by their labours seem to be able only to increase their dependence upon private charity and public doles. Universities sow the seed, and their claims, like the claims of the farmer for seed for his future harvest, ought to be absolutely the first charge upon the yearly revenue. It is as idle to say the country cannot afford it as it would be for a farmer to grudge the seed for his next year's crop. It affords a plethora of most expensive evils and unnecessary luxuries. In the spirit of one of the early Methodist preachers, I feel, whenever I see a specially sumptuous motor-car, "There, but for the grace of Parliament, goes a professor of chemistry"; and even a humble two-seater might in happier circumstances have become a demonstrator!

Under the scheme of a professor of literature with fifteen years' experience of fostering scientific research with the Carnegie Trust, a million of the taxpayers' money is now well on its way to provide more sumptuous motor-cars rather than professors of chemistry, and another two millions or so to foster dye-making as it is understood in the City by directors more innocent of the art than our early woad-besmeared ancestors. To such ill-informed and costly efforts the complete indifference with which science was regarded in official circles before the war is surely preferable. It may be difficult to break with the habit of a hundred years in patiently expecting a miraculous change of attitude on the part of the Government towards the debt- and wealth-producing elements of the community respectively. A more practical and practically attainable objective would, it seems to me, be for the universities to ally themselves with Labour to provide saner government. Incidentally, some long overdue reforms of the universities might then be effected, and the paralysing and deliberate stranglehold of the old vested interests upon science broken, once for all.

I may merely be more outspoken than my colleagues, but I believe I am more scientific in diagnosing the trouble before seeking a remedy. The failure of a century's efforts on the part of scientific men is not due to ignorance, apathy, or any other negative cause. But for the clever, tireless, and all-embracing activities of all those to whom science spells *finis*, the existing absurdities would not survive a year, and against this combination Labour is the only real force. The unpopularity of the proposed remedy with all those who have proved themselves such good friends of science in the past is, to my mind, an unsolicited testimonial to its efficiency from a quarter eminently in a position to judge.

FREDERICK SODDY.

The Separation of the Isotopes of Chlorine.

IN my letter to NATURE of June 17 I showed that inappreciable separability of the isotopes of chlorine by a special class of chemical change would be difficult to reconcile with Nernst's heat theorem, and in a later issue of NATURE (July 15), at the request of Prof. Soddy, the argument was more fully given. Mr. Core (NATURE, July 29) has endeavoured to remove the difficulty to which attention was directed by me. With most of his deductions I agree, but I am not satisfied that he has reconciled Nernst's theory with the inappreciable separability of the isotopes by the specified chemical method. Mr. Core contends that the solid compound ClCl′ which would actually be formed in the chemical change represented by the equation

$$Cl_2 + Cl'_2 = 2ClCl'$$

is a solid solution—since in the crystal the molecules would be indifferently oriented as ClCl′ or Cl′Cl—and Nernst's theorem cannot be applied to solutions.

Now Nernst states his theorem as follows:

"I have been led to the conclusion that not only do A and U become equal at the absolute zero of temperature, but that their *curves touch asymptotically at this point*. That is to say,

$$\lim \frac{dA}{dT} = \lim \frac{dU}{dT} \text{ (for } T = 0).$$

It is to be remembered that this equation is only strictly applicable to pure solid or liquid substances" (H. T. Tizard's translation of Nernst's "Theoretical Chemistry," 1916 edition, p. 746).

Again, Nernst (*loc. cit.*, p. 748) identifies liquid with amorphous substances

Further, Planck limits the application of his more general enunciation of Nernst's theorem to chemically homogeneous substances, which he defines as substances made up of nothing but molecules of the same kind (Max Planck, "Thermodynamik," § 67).

Neither of these definitions appears to me to exclude the crystalline modifications of ClCl′, which are stable at finite temperatures. But even if it be conceded that the intention was to exclude such solid compounds, the difficulty I find in reconciling Nernst's heat theorem with the inappreciable separability of the isotopes by the specified chemical method has not been removed, for the solid substances taken in performing the thermodynamic cycles can (without modifying the reasoning) be the liquid (amorphous) forms.

D. L. CHAPMAN.

Jesus College, Oxford.

The Scratch-Reflex in the Cat.

I HAD lately the opportunity of examining in a young cat eight weeks old the conditions of the scratch-reflex, and the results would seem to be worth noting. The animal had been through an unusually heavy day of play on a hot day, and in the evening was lying asleep on the lap of one of her friends in a profound sleep. I thought this a good occasion for finding out what reactions she would show to gentle mechanical stimuli. A very light touch with a wooden match on the conchal surface of the pinna, or one extending to the meatus, produced immediate response as follows:—First, the facial muscles on the same side twitched irregularly; this ceased, and then the fore foot was moved irregularly towards, but not so far as, the ear; when this had ceased there occurred at once a *rhythmical* movement of the hind limb, with a rate closely similar to that of the scratch-reflex of the dog, the hind foot, as in the fore foot, being brought *towards*, but not up to, the ear.

This unusual sleep lasted for a quarter of an hour, during which repeated light mechanical stimuli of various kinds failed to wake the animal, and the above series of reactions was frequently evoked, but none of the later attempts produced results so strongly marked as the first. I was unfortunate then in not having read more than an abstract of the paper in the *Journal of Physiology* of December, 1917, by Prof. Sherrington on "The Pinna Reflexes in the Cat." He has now very kindly sent me a copy of the paper, and I see how much better I might have marked out the receptive field of this reflex if I had known the accurate observations he has made on it.

I examined in this animal then and since the various regions of the back and flanks, and have found there no receptive field like that of the dog, which seems to be in accordance with the experience of others. Since the first occasion I have found the foregoing reactions present many times, but the sleep has always been lighter and the results less orderly and striking.

WALTER KIDD.

Chalet le Mourezin, Château d'Oex,
Switzerland, August 13.

Portraits Wanted.

I SHOULD greatly appreciate any information readers of NATURE may be able to give me which would lead to the discovery of portraits of any of the following early myriapodologists:—Shaw (who published a paper in 1789, Trans. Linn. Soc., vol. ii., p. 7), W. E. Leach, George Newport, John Edward Gray, and John Curtis. The last four all published papers during the first half of the nineteenth century.

S. GRAHAM BRADE-BIRKS.

16 Bank Street, Darwen, Lancs, August 19.

The Christian Revelation and Modern Science.[1]

By the Rev. E. W. Barnes, M.A., Sc.D., F.R.S., Canon of Westminster.

"I am the Light of the world."—St. John viii. 12.

I HAVE been asked to preach here to-day in connection with the meeting of the British Association which has been held in this city during the past week. My subject is Christ, the Light of the world, and I ask you to think of the Christian revelation and scientific progress. For more than a hundred years there has been strife—sometimes veiled, but more often open—between "religion and science." I use the popular phraseology. More accurately, opinions as to the origins of the earth and of man which were held as a result of Christian tradition have been directly challenged by a succession of novel theories put forward by men of science. At the beginning of last century the foundations of geology were being laid, largely in this country. Gradually it became clear, from a study of our rocks and their fossil remains, that the earth had an almost unimaginable antiquity. The coal which we dig is all that is left of vast tropical forests that once flourished here for tens of thousands of years. In successive ages of vast duration the most diverse forms of animal life have existed in these lands. The East of England has repeatedly for long periods been submerged beneath the sea. The climate has varied from tropical heat to arctic severity.

Such knowledge is now a commonplace. But when it was being established by patient discovery during the early part of last century Christian theologians showed violent hostility to the new ideas. The curious may examine the expression of this hostility in Bampton Lectures of the period, which are now happily forgotten. On second-hand bookstalls it is not uncommon to find pathetic attempts to reconcile geology and Genesis such as were continually made even to our own time. But truth triumphed. Just as two centuries earlier the Roman Church had failed to prevent men from receiving the then new knowledge that the earth was not the fixed centre of the universe, so the new geological ideas won their way despite religious prejudice. Galileo triumphed; it is agreed that the earth moves round the sun; heliocentric books were removed from the Roman Index in 1835. The early nineteenth-century geologists triumphed; it is agreed that life has existed on this earth for something like a hundred million years. Though in each case the new views are directly opposed to those which Christianity took over from Judaism, we accept them with confidence and surely without harm to our faith in Christ.

But sixty years ago a far more vital controversy began when the Biblical account of man's origin was disputed. A series of discoveries in caves and river-beds in England and in France made it clear that primitive men had lived here when the mammoth, the cave lion, and the rhinoceros flourished in Western Europe. Evidence quickly accumulated which showed that even in this corner of the world human beings existed more than a hundred thousand years ago. Scarcely had these novel conclusions been reached when a scientific theory was put forward which to the great majority of the religious people of the time seemed destructive of essentials in our faith. It was in the year 1859 that Darwin, in his book "The Origin of Species," urged the truth of the doctrine of evolution. At the ensuing Oxford meeting of the British Association, Bishop Wilberforce denounced the idea that man shared a common ancestry with the higher apes. His speech showed deplorable prejudice; it contained a grave error in taste, and Huxley's dignified rebuke of the Bishop is still remembered. For forty years after that famous encounter evolution was a *casus belli* between religion and science. Christian opinion refused to accept the new doctrine, and religious teachers traversed it by arguments good and bad. It is not fair to regard them with the scorn which the younger people of to-day, trained in modern science, not seldom feel.

Evolution was, and still is, not an observed fact, but a very probable theory. Our forefathers saw that acceptance of it meant the abandonment of the story of Adam; it meant giving up belief in the Fall, and in all the theology built upon it by theologians from St. Paul onwards. Half a century ago, the evolutionary view of man's origin meant that what then appeared to be the strongest reasons for the belief that man has an immortal soul had to be set aside. But truth has triumphed. In our own time the leaders of Christian thought have, with substantial unanimity, accepted the conclusion that biological evolution is a fact; man is descended from the lower animals. It is even becoming common to say that there is no quarrel between science and religion. But let us be honest. There has as regards the origin of man been a sharp conflict between science and traditional religious belief, and the battle has been won by science. Furthermore, let us not when driven from one position take up another that may have to be abandoned. It is dangerous to assert that, although God may not have specially created man, nevertheless He did specially create life. Probably the beginning of terrestrial life was but a stage in the great scheme of natural evolution. We may even expect that some day in the laboratory the man of science will produce living from non-living matter.

The time has come when we must not try to evade any implications of the theory of natural evolution. We must, not silently, but explicitly, abandon religious dogmas which it overthrows. We must, moreover, avoid the temptation to allegorise beliefs which it is no longer possible

[1] Sermon preached in St. John's Church, Cardiff, on Sunday, August 29, to members of the British Association.

to hold. Allegory has its value, but it is misused when we employ it to obscure the revolutionary consequences of new knowledge. Religion is too important for us to base it upon, or to join it to, any theories of the nature of the universe that are doubtful or untrue. If Christ is the Light of the world, all intellectual discovery must be a part of His revelation. If He rightly explained the nature and purpose of God, then the more accurately we discover how God planned and guided the universe so that men have come to exist upon earth, the more natural will it be to accept Christ's teaching. If, on the contrary, the progress of knowledge really discredits the Christian faith, in so far as that faith comes from Jesus Christ, we must sadly admit that Christ cannot have been the Light of mankind. Whatever the consequences, we must accept truth by whomsoever it may have been discovered. A religion not based on truth is vain. A faith that fears the progress of knowledge anticipates its own dissolution.

Now, the Christian faith is belief in Christ, in His Person, and in His teaching. If Jesus was Divine, His spiritual revelation was without error, His example perfect. In so far as He was man we expect His secular knowledge to have been that of the Galilean carpenter's son. But we can no longer call ourselves Christians if we find that we are forced to admit that He was morally imperfect or mistaken in His view of God or of man's relation to God. I contend that the progress of science has not forced us to make any such admission. It has not destroyed the spiritual infallibility of our Lord, or done anything to upset His teaching as to the nature of God, or as to man's nature and destiny. It has rather, as I hold, confirmed His insight and made His spiritual wisdom more profoundly impressive.

Traditional Christian belief was built up of other things besides Christ's teaching. The early Christian Church took over the old Jewish Scriptures because it deemed them inspired by God. It placed among its sacred books writings of St. Paul and other earlier followers of the Lord because it found that they reflected the Mind of the Master. But there never was a time when thoughtful Christians could thoughtfully have maintained that the Jewish Scriptures were free from moral and historical error. The cursing Psalms are obviously un-Christian. Books like Kings and Chronicles are rival histories which disagree in spirit and in detail. As a matter of fact, the Church has never formally defined inspiration. We may say truly that inspired books are of peculiar spiritual value; but we may find such value in St. Paul's teaching, though we freely admit that his arguments were sometimes unsound. If we discover that old Christian beliefs which did not come from Christ are erroneous let us not be troubled. For Christianity the perfection of Christ's religious teaching and His revelation of His own supreme excellence are alone of decisive importance. Views of ancient Jews or of early Apostles we can abandon when we discover that they were wrong. Christianity is belief in Christ as Way, Truth, and Life; belief that He was the Light of the world, the Guide of the spiritual evolution of humanity. It is not belief in the scientific value of Genesis or even in the infallibility of St. Paul. Grasp this fact firmly and you will understand that last century's tragic quarrel between religion and science had its origin in a natural, but none the less deplorable, mistake. The mistake was natural, for there is so much of supreme value in the books of the Bible that men will always venerate them profoundly. In the recent past veneration led to exaggeration, to the claim of infallibility. Let us thank God that men of science have forced us to get a fuller, if more difficult, type of understanding of the value of the Bible.

But some of you may say, Has not the new knowledge made it impossible to accept the teaching of Jesus with regard to God and human immortality? Can we accept evolution and yet believe that God, a loving Father, made the world? Can we accept the idea that man and the gorilla have sprung from a common stock and yet hold that man has an immortal soul? I answer emphatically that we can. I remain sure that God, Who is Love, made and rules the world, certain that man was created that he might enjoy eternal life in communion with God in the world to come. Do you doubt? Reflect for a few moments. Surely the universe had a beginning, and therefore a Creator. It cannot be a meaningless dance of atoms or a whirl of electrons that has gone on for an infinite time. Surely, too, evolution describes a wonderful development, an upward progress, which implies a design in the mind of God. Surely man is on earth the present end of this process, and his spiritual qualities, his love of beauty, goodness, and truth, are its crown. Surely, moreover, the God Who by a design extending over hundreds of millions of years has called these spiritual qualities into existence is Himself a spiritual Being Who made spiritual man for communion with Himself. And, last of all, surely the finest products of evolution have not been made for nothing. And yet, in the distant future, when all life vanishes from the earth, as it certainly must, heroes and saints will in vain have gained knowledge of God, in vain have spent their strength, unless they continue to live eternally in the spiritual world.

Evolution seemed disastrous to faith two generations ago because men fixed their attention narrowly on but one part of the process. Now a wider vista seems to be coming into view as theories are tested by experiment and unified by the speculative reason. From some fundamental stuff in the universe the electrons arose. From them came matter. From matter life emerged. From life came mind. From mind spiritual consciousness developed. At every stage, in this vast process and progress, something new has come, we know not how, into existence. There was a time when matter, life, mind, the soul of man were not; but now they are. Each has arisen as part of a vast scheme planned by God. And the soul of man is the glory of the whole design. Because of the soul within him man, as Jesus taught, is meant to be the child of God. As our souls grow through the quickening power of the Spirit of Christ we can on earth know and serve the Father of us all and begin to enjoy that Divine communion which is eternal life. The Christ Spirit within us, the "quality of deity," as it has been called, separates us from the animals whence we have sprung just as life separates them from the matter of which they are made. And through the Spirit of Christ we put on immortality, for the things that are of God are eternally with God.

Science describes the process by which man has come into being. Religion takes man as he is and offers him guidance towards his spiritual destiny. Between the religious revelation of Jesus and modern science there is no opposition. The two dovetail into one another with singular exactness. Evolution describes facts; the ultimate meaning of those facts Christ's teaching discloses. We need faith to accept the Lord's message; we cannot prove its truth by the methods of scientific inquiry, for the spiritual world is a type of reality which the organs of sense will not reveal. But by living the Christian life, by prayer and communion with God, we can continuously strengthen the faith which is not sight, and become ever more confident that the Lord was in very truth the Light of the world.

The British Association at Cardiff.

THE Cardiff meeting of the British Association came to an end on Sunday morning, when the Lord Mayor of Cardiff (Councillor G. F. Forsdike) and the Corporation, with the general officers of the Association and some of the members, attended the service at St. John's Church. The Association sermon was preached by Canon E. W. Barnes, F.R.S., and we are glad to be able to reproduce it this week. The scientific work of the Association concluded on Friday evening, August 27, when Sir Daniel Hall delivered a stimulating discourse under the title of "A Grain of Wheat from the Field to the Table." A comprehensive vote of thanks to the Lord Mayor, Corporation, and citizens of Cardiff was carried with acclamation, and was responded to by the Lord Mayor and by Dr. W. Evans Hoyle, whose valuable work as local secretary was much appreciated by all.

There were 1378 members present during the week, but the meeting, though relatively small, has been particularly interesting from the scientific point of view. Among the new features was a conference on "Science applied to Public Services," held on August 26, when Mr. F. E. Smith, director of scientific research at the Admiralty, described the admirable scheme of research which has recently been introduced (see NATURE, April 22, p. 245). Prof. C. F. Jenkin, Mr. J. Barcroft, Sir Francis Ogilvie, and Dr. J. W. Evans referred to similar research work in other Government Departments. It was felt that a similar conference, with perhaps some description of results obtained, so far as they can be made public, and opportunity for free and adequate discussion, could usefully be held at each meeting.

As we stated last week, a message was sent from the inaugural meeting to the King in Scotland, where the Association is to meet next year. The message was as follows:—"The members of the British Association for the Advancement of Science desire to express their loyal devotion to your Majesty, and at their meeting in the Principality of Wales hope that they may be permitted to congratulate your Majesty on the splendid work done by the Prince of Wales, which has drawn towards him the thoughts and the hearts of the whole Empire."

The King, in thanking the Association through Sir Charles Parsons, the retiring president, for this loyal greeting, added:—"I feel greatly touched at the kind references to my son, which are the more appreciated coming as these do from members of this distinguished society assembled in the Principality of Wales. I shall follow your deliberations with close interest, and I gratefully recognise all that is being done for the advancement of civilisation by the men of science."

There is probably no more remarkable example of the scientific spirit which animates the British Association than that displayed in the allocation of its annual grants for research purposes. Each section of the Association nominates research committees, and most of them apply for small grants to carry out the work and defray the clerical and other incidental expenses involved. A total of about 1000*l*. a year is voted by the Committee of Recommendations to these committees and approved by the General Committee, and every pound of this comes out of the subscriptions of the members. This year the amount voted in grants for research was about 1100*l*., part of which will be required for expenses of publication. It is hoped some external support will be forthcoming for this branch of the Association's work, and that Government Departments interested in particular subjects will assist in the publication of some of the reports prepared by research committees.

Among the corresponding members and other foreign representatives present at the meeting were:—M. Brieux (Directeur de la Station Agronomique de Rouen, France); M. Bruno (Insp. Gén. des Stations Agronomiques, Paris); Prof. C. J. Chamberlain (Chicago); Prof. R. Chodat (Geneva); Dr. S. I. Franz (George Washington

University, representing the American Association); Prof. A. Gilson (Louvain, Belgium); Prof. R. W. Hegner (Dept. Medical Zoology, Johns Hopkins University); Prof. F. Jaeger (Groningen); Prof. C. A. Kofoid (University of California); Prof. Graham Lusk (Cornell University Medical College); Dr. Naser (representing the International Students' Union, University of Copenhagen); Don G. J. de Osma (Madrid); and Yoshimaro Tanaka (Japan). The General Committee has resolved that national associations for the advancement of science shall in future be invited to send representatives to meetings of the British Association.

The new members of the Council are:—Mr. Joseph Barcroft, Prof. J. Stanley Gardiner, Sir Daniel Hall, Dr. Chalmers Mitchell, and Sir W. J. Pope.

Next year's meeting at Edinburgh, under the presidency of Sir Edward Thorpe, will be from Wednesday, September 7, to Wednesday, September 14. In the following year the meeting will be held at Hull, an invitation tendered by the Lord Mayor and the Town Clerk of that city having been unanimously accepted by the General Committee. No further meetings were actually arranged at Cardiff, but there is a possibility that the meeting in 1923 will be in another northern city, and invitations have been received to meet in Canada in 1924.

Dr. R. V. Stanford, secretary of the Press and Publicity Sub-Committee at Cardiff, who acted as our local correspondent for the meeting, has sent us the following statement, which merits the attention of the Council of the Association and of local committees organising the annual meetings. We are sure that, in making these comments, Dr. Stanford is as desirous of increasing public interest in the work of the Association as we are in publishing it.

"It is difficult to resist taking this opportunity to make one or two observations, though in proposing to offer any criticisms of such a great and venerable institution as the British Association one has rather the feelings of a curate meditating a mild attack on his bishop. There are many members of the Association who are of the opinion that some changes in its policy are not only desirable, but are also rapidly becoming inevitable. Now is the time to take stock of the position, for the recent meeting at Cardiff was really the first normal post-war meeting. The Bournemouth meeting could scarcely be called so, because of its situation and of the very general curiosity regarding war secrets. It is, therefore, rather disappointing to find the membership no greater. What is more disappointing still is that the principal reason for this is the apathy of local people of the educated classes to the presence of the Association. The plain fact remains that it is the exception to find anyone who has even heard of the Association. Is this regrettable state of affairs due to something lacking in these individuals themselves, or is the blame to be laid at the door of the Association? It certainly is not peculiar to Cardiff.

"Everyone will agree that the Association serves three main purposes, namely, to furnish opportunity for scientific workers themselves to get in touch with men working on allied subjects, to try to encourage research, and (what some of us think most important of all) to make scientific knowledge accessible to the general public. It may very well be maintained that the first two of these purposes are being very much better served than the third. Some lay organ of the Press referred to this Cardiff meeting as a 'jamboree of science.' So it was—for the scientific men. But if we were the scouts, where were the delighted parents, who should be such a feature of the entertainment? The point of this analogy is that while the scientific men themselves had four whole days in twelve sections to meet each other and discuss matters in a way of little intelligibility to anyone but themselves, the educated man in the street could only expect a couple of evening discourses to interest him, with a possibility of three more if there was room. The local Press reported the meetings astonishingly well, but such reports, however widely they may be read, do not take the place of a full lecture.

"The importance of scientific work will never be recognised adequately by the general public until they are better instructed as to the practical results which are to be expected from it, and this end can be reached only by the leaders of scientific thought and discovery going out of their way to show the ordinary man that he has a personal interest in the matter. It cannot be pretended that this result is properly secured by five lectures during the whole meeting. We should like to have seen fifty of them, and to have seen them delivered, not to the scientific, but to the non-scientific, public. What is being suggested is not a return to what might be called the lecture habit of the Victorian period, often a perfectly useless type of scientific conjuring entertainment. It is also not necessarily implied that they shall be delivered in the largest hall in the district: sectional meeting rooms would do in many cases.

"Some change in this direction has been referred to above as desirable, and also as inevitable. The inevitability arises from the need which is bound to be felt by the Association of increasing its membership, and consequently its financial resources, rather than the reverse. There are certainly some points that might be thought of, which would result, for example, in a considerable reduction of expenditure for the meeting, and that is a matter which cannot be neglected in these days of high wages and long prices, either by the Association or by its hosts from year to year. A great saving of time and trouble would be effected by the adoption of some method of getting an idea before the meeting as to how many people were coming. This might be done by adding a surcharge to the price of any tickets sold after a certain date. The same consideration applies to excursions: it is easy to lose considerable sums in the way of guarantees for motor transport and meals."

The Internal Constitution of the Stars.*

By PROF. A. S. EDDINGTON, M.A., M.Sc., F.R.S.

LAST year at Bournemouth we listened to a proposal from the President of the Association to bore a hole in the crust of the earth and discover the conditions deep down below the surface. This proposal may remind us that the most secret places of Nature are, perhaps, not 10 to the *n*th miles above our heads, but 10 miles below our feet. In the last five years the outward march of astronomical discovery has been rapid, and the most remote worlds are now scarcely safe from its inquisition. By the work of H. Shapley the globular clusters, which are found to be at distances scarcely dreamt of hitherto, have been explored, and our knowledge of them is in some respects more complete than that of the local aggregation of stars which includes the sun. Distance lends not enchantment, but precision, to the view. Moreover, theoretical researches of Einstein and Weyl make it probable that the space which remains beyond is not illimitable; not merely the material universe, but also space itself, is perhaps finite; and the explorer must one day stay his conquering march for lack of fresh realms to invade. But to-day let us turn our thoughts inwards to that other region of mystery—a region cut off by more substantial barriers, for, contrary to many anticipations, even the discovery of the fourth dimension has not enabled us to get at the inside of a body. Science has material and non-material appliances to bore into the interior, and I have chosen to devote this address to what may be described as analytical boring devices —*absit omen!*

The analytical appliance is delicate at present, and, I fear, would make little headway against the solid crust of the earth. Instead of letting it blunt itself against the rocks, let us look round for something easier to penetrate. The sun? Well, perhaps. Many have struggled to penetrate the mystery of the interior of the sun; but the difficulties are great, for its substance is denser than water. It may not be quite so bad as Biron makes out in "Love's Labour's Lost":

> The heaven s glorious sun
> That will not be deep-search'd with saucy looks:
> Small have continual plodders ever won
> Save base authority from others' books.

But it is far better if we can deal with matter in that state known as a perfect gas, which charms away difficulties as by magic.* Where shall it be found?

A few years ago we should have been puzzled to say where, except perhaps in certain nebulæ; but now it is known that abundant material of this kind awaits investigation. Stars in a truly gaseous state exist in great numbers, although at first sight they are scarcely to be discriminated from dense stars like our sun. Not only so, but the gaseous stars are the most powerful light-givers, so that they force themselves on our attention. Many of the familiar stars are of this kind —Aldebaran, Canopus, Arcturus, Antares; and it would be safe to say that three-quarters of the naked-eye stars are in this diffuse state. This remarkable condition has been made known through the researches of H. N. Russell (NATURE, vol. xciii., pp. 227, 252, 281) and E. Hertzsprung; the way in which their conclusions, which ran counter to the prevailing thought of the time, have been substantiated on all sides by overwhelming evidence is the outstanding feature of recent progress in stellar astronomy.

The diffuse gaseous stars are called *giants*, and the dense stars *dwarfs*. During the life of a star there is presumably a gradual increase of density through contraction, so that these terms distinguish the earlier and later stages of stellar history. It appears that a star begins its effective life as a giant of comparatively low temperature—a red or M-type star. As this diffuse mass of gas contracts its temperature must rise, a conclusion long ago pointed out by Homer Lane. The rise continues until the star becomes too dense, and ceases to behave as a perfect gas. A maximum temperature is attained, depending on the mass, after which the star, which has now become a dwarf, cools and further contracts. Thus each temperature-level is passed through twice, once in an ascending and once in a descending stage—once as a giant, once as a dwarf. Temperature plays so predominant a part in the usual spectral classification that the ascending and descending stars were not originally discriminated, and the customary classification led to some perplexities. The separation of the two series was discovered through their great difference in luminosity, particularly striking in the case of the red and yellow stars, where the two stages fall widely apart in the star's history. The bloated giant has a far larger surface than the compact dwarf, and gives correspondingly greater light. The distinction was also revealed by direct determinations of stellar densities, which are possible in the case of eclipsing variables like Algol. Finally, Adams and Kohlschütter have set the seal on this discussion by showing that there are actual spectral differences between the ascending and descending stars at the same temperature-level, which are conspicuous enough when they are looked for.

Perhaps we should not too hastily assume that the direction of evolution is necessarily in the order of increasing density, in view of our ignorance of the origin of a star's heat, to which I must allude later. But, at any rate, it is a great advance to have disentangled what is the true order of continuous increase of density, which was hidden by superficial resemblances.

The giant stars, representing the first half of a star's life, are taken as material for our first boring experiment. Probably, measured in time, this stage corresponds to much less than half the life, for here it is the ascent which is easy and the way down is long and slow. Let us try to picture the conditions inside a giant star. We need not dwell on the vast dimensions—a mass like that of the sun, but swollen to much greater volume on account of the low density, often below that of our own atmosphere. It is the star as a storehouse of heat which especially engages our attention. In the hot bodies familiar to us the heat consists in the energy of motion of the ultimate particles, flying at great speeds hither and thither. So, too, in the stars a great store of heat exists in this form; but a new feature arises. A large proportion, sometimes more than half the total heat, consists of imprisoned radiant energy—æther-waves travelling in all directions trying to break through the material which encages them. The star is like a sieve, which can retain them only temporarily; they are turned aside, scattered, absorbed for a moment, and flung out again in a new direction. An element of energy may thread the maze for hundreds of years before it attains the freedom of outer space. Nevertheless, the sieve leaks, and a steady stream permeates outwards, supplying the light and heat which the star radiates all round.

That some æthereal heat as well as material heat exists in any hot body would naturally be admitted; but the point on which we have here to lay stress is

*Opening address of the president of Section A (Mathematical and Physical Science) delivered at the Cardiff meeting of the British Association on August 24.

that in the stars, particularly in the giant stars, the æthereal portion rises to an importance which quite transcends our ordinary experience, so that we are confronted with a new type of problem. In a red-hot mass of iron the æthereal energy constitutes less than a billionth part of the whole; but in the tussle between matter and æther the æther gains a larger and larger proportion of the energy as the temperature rises. This change in proportion is rapid, the æthereal energy increasing rigorously as the fourth power of the temperature, and the material energy roughly as the first power. But even at the temperature of some millions of degrees attained inside the stars there would still remain a great disproportion; and it is the low density of material, and accordingly the reduced material energy per unit volume in the giant stars, which wipes out the last few powers of 10. In all the giant stars known to us, widely as they differ from one another, the conditions are just reached at which these two varieties of heat-energy have attained a rough equality; at any rate, one cannot be neglected compared with the other. Theoretically there could be conditions in which the disproportion was reversed and the æthereal far outweighed the material energy; but we do not find them in the stars. It is as though the stars had been measured out—that their sizes had been determined—with a view to this balance of power; and one cannot refrain from attributing to this condition a deep significance in the evolution of the cosmos into separate stars.

To recapitulate. We are acquainted with heat in two forms—the energy of motion of material atoms and the energy of æther waves. In familiar hot bodies the second form exists only in insignificant quantities. In the giant stars the two forms are present in more or less equal proportions. That is the new feature of the problem.

On account of this new aspect of the problem the first attempts to penetrate the interior of a star are now seen to need correction. In saying this we do not depreciate the great importance of the early researches of Lane, Ritter, Emden, and others, which not only pointed the way for us to follow, but also achieved conclusions of permanent value. One of the first questions they had to consider was by what means the heat radiated into space was brought up to the surface from the low level where it was stored. They imagined a bodily transfer of the hot material to the surface by currents of convection, as in our own atmosphere. But actually the problem is, not how the heat can be brought to the surface, but how the heat in the interior can be held back sufficiently—how it can be barred in and the leakage reduced to the comparatively small radiation emitted by the stars. Smaller bodies have to manufacture the radiant heat which they emit, living from hand to mouth; the giant stars merely leak radiant heat from their store. I have put that much too crudely; but perhaps it suggests the general idea.

The recognition of æthereal energy necessitates a twofold modification in the calculations. In the first place, it abolishes the supposed convection currents; and the type of equilibrium is that known as radiative instead of convective. This change was first suggested by R. A. Sampson so long ago as 1894. The detailed theory of radiative equilibrium is particularly associated with K. Schwarzschild, who applied it to the sun's atmosphere. It is perhaps still uncertain whether it holds strictly for the atmospheric layers, but the arguments for its validity in the interior of a star are far more cogent. Secondly, the outflowing stream of æthereal energy is powerful enough to exert a *direct mechanical effect* on the equilibrium of a star. It is as though a strong wind were rushing outwards. In fact, we may fairly say that the stream of radiant energy *is* a wind; for though æther waves are not usually classed as material, they have the chief mechanical properties of matter, viz. mass and momentum. This wind distends the star and relieves the pressure on the inner parts. The pressure on the gas in the interior is not the full weight of the superincumbent columns, because that weight is partially borne by the force of the escaping æther waves beating their way out. This force of radiation-pressure, as it is called, makes an important difference in the formulation of the conditions for equilibrium of a star.

Having revised the theoretical investigations in accordance with these considerations (*Astrophysical Journal*, vol. xlviii., p. 205), we are in a position to deduce some definite numerical results. On the observational side we have fairly satisfactory knowledge of the masses and densities of the stars and of the total radiation emitted by them; this knowledge is partly individual and partly statistical. The theoretical analysis connects these observational data on the one hand with the physical properties of the material inside the star on the other. We can thus find certain information as to the inner material, as though we had actually bored a hole. So far as can be judged, there are only two physical properties of the material which can concern us—always provided that it is sufficiently rarefied to behave as a perfect gas—viz. the average molecular weight and the transparency or permeability to radiant energy. In connecting these two unknowns with the quantities given directly by astronomical observation we depend entirely on the well-tried principles of conservation of momentum and the second law of thermodynamics. If any element of speculation remains in this method of investigation, I think it is no more than is inseparable from every kind of theoretical advance.

We have, then, on one side the mass, density, and output of heat, quantities as to which we have observational knowledge; on the other side, molecular weight and transparency, quantities which we want to discover.

To find the transparency of stellar material to the radiation traversing it is of particular interest, because it links on this astronomical inquiry to physical investigations now being carried on in the laboratory, and to some extent it extends those investigations to conditions unattainable on the earth. At high temperatures the æther waves are mainly of very short wave-length, and in the stars we are dealing mainly with radiation of wave-length 3 to 30 Ångström units, which might be described as very soft X-rays. It is interesting, therefore, to compare the results with the absorption of the harder X-rays dealt with by physicists. To obtain an exact measure of this absorption in the stars we have to assume a value of the molecular weight; but fortunately the extreme range possible for the molecular weight gives fairly narrow limits for the absorption. The average weight of the ultimate independent particles in a star is probably rather low, because in the conditions prevailing there the atoms would be strongly ionised; that is to say, many of the outer electrons of the system of the atom would be broken off; and as each of these free electrons counts as an independent molecule for present purposes, this brings down the average weight. In the extreme case (probably not reached in a star) when the whole of the electrons outside the nucleus are detached the average weight comes down to about 2, *whatever the material*, because the number of electrons is about half the atomic weight for all the elements (except hydrogen). We may, then, safely take 2 as the extreme lower limit. For an upper limit we might perhaps take

200; but to avoid controversy we shall be generous and merely assume that the molecular weight is not greater than—infinity. Here is the result:—

For molecular weight 2, mass-coefficient of absorption = 10 C.G.S. units.

For molecular weight ∞, mass-coefficient of absorption = 130 C.G.S. units.

The true value, then, must be between 10 and 130. Partly from thermodynamical considerations, and partly from further comparisons of astronomical observation with theory, the most likely value seems to be about 35 C.G.S. units, corresponding to molecular weight 3·5.

Now this is of the same order of magnitude as the absorption of X-rays measured in the laboratory. I think the result is in itself of some interest, that in such widely different investigations we should approach the same kind of value of the opacity of matter to radiation. The penetrating power of the radiation in the star is much like that of X-rays; more than half is absorbed in a path of 20 cm. at atmospheric density. Incidentally, this very high opacity explains why a star is so nearly heat-tight, and can store vast supplies of heat with comparatively little leakage.

So far this agrees with what might have been anticipated; but there is another conclusion which physicists would probably not have foreseen. The giant series comprises stars differing widely in their densities and temperatures, those at one end of the series being on the average about ten times hotter throughout than those at the other end. By the present investigation we can compare directly the opacity of the hottest stars with that of the coolest. The rather surprising result emerges that the opacity is the same for all; at any rate, there is no difference large enough for us to detect. There seems no room for doubt that at these high temperatures the absorption-coefficient is approaching a limiting value, so that over a wide range it remains practically constant. With regard to this constancy, it is to be noted that the temperature is concerned twice over: it determines the character and wave-length of the radiation to be absorbed, as well as the physical condition of the material which is absorbing. From the experimental knowledge of X-rays we should have expected the absorption to vary very rapidly with the wave-length, and therefore with the temperature. It is surprising, therefore, to find a nearly constant value

The result becomes a little less mysterious when we consider more closely the nature of absorption. Absorption is not a continuous process, and after an atom has absorbed its quantum it is put out of action for a time until it can recover its original state. We know very little of what determines the rate of recovery of the atom, but it seems clear that there is a limit to the amount of absorption that can be performed by an atom in a given time. When that limit is reached no increase in the intensity of the incident radiation will lead to any more absorption. There is, in fact, a saturation effect. In the laboratory experiments the radiation used is extremely weak; the atom is practically never caught unprepared, and the absorption is proportional to the incident radiation. But in the stars the radiation is very intense and the saturation effect comes in.

Even granting that the problem of absorption in the stars involves this saturation effect, which does not affect laboratory experiments, it is not very easy to understand theoretically how the various conditions combine to give a constant absorption-coefficient independent of temperature and wave-length. But the astronomical results seem conclusive. Perhaps the most hopeful suggestion is one made to me a few years ago by C. G. Barkla. He suggested that the opacity of the stars may depend mainly on *scattering* rather than on true atomic absorption. In that case the constancy has a simple explanation, for it is known that the coefficient of scattering (unlike true absorption) approaches a definite constant value for radiation of short wave-length. The value, moreover, is independent of the material. Further, scattering is a continuous process, and there is no likelihood of any saturation effect; thus for very intense streams of radiation its value is maintained, whilst the true absorption may sink to comparative insignificance. The difficulty in this suggestion is a numerical discrepancy between the known theoretical scattering and the values already given as deduced from the stars. The theoretical coefficient is only 0·2 compared with the observed value 10 to 130. Barkla further pointed out that the waves here concerned are not short enough to give the ideal coefficient; they would be scattered more powerfully, because under their influence the electrons in any atom would all vibrate in the same phase instead of in haphazard phases. This might help to bridge the gap, but not sufficiently. It must be remembered that many of the electrons have broken loose from the atom and do not contribute to the increase.[1] Making all allowances for uncertainties in the data, it seems clear that the astronomical opacity is definitely higher than the theoretical scattering. Very recently, however, a new possibility has opened up which may possibly effect a reconciliation. Later in the address I shall refer to it again.

Astronomers must watch with deep interest the investigations of these short waves, which are being pursued in the laboratory, as well as the study of the conditions of ionisation by both experimental and theoretical physics, and I am glad of this opportunity of bringing before those who deal with these problems the astronomical bearing of their work.

I can allude only very briefly to the purely astronomical results which follow from this investigation (Monthly Notices, vol. lxxvii., pp. 16, 596; vol. lxxix., p. 2); it is here that the best opportunity occurs for checking the theory by comparison with observation, and for finding out in what respects it may be deficient. Unfortunately, the observational data are generally not very precise, and the test is not so stringent as we could wish. It turns out that (the opacity being constant) the total radiation of a giant star should be a function of its mass only, independent of its temperature or state of diffuseness. The total radiation (which is measured roughly by the luminosity) of any one star thus remains constant during the whole giant stage of its history. This agrees with the fundamental feature, pointed out by Russell in introducing the giant and dwarf hypothesis, that giant stars of every spectral type have nearly the same luminosity. From the range of luminosity of these stars it is now possible to find their range of mass. The masses are remarkably alike—a fact already suggested by work on double stars. Limits of mass in the ratio 3:1 would cover the great majority of the giant stars. Somewhat tentatively we are able to extend the investigation to dwarf stars, taking account of the deviations of dense gas from the ideal laws and using our own sun to supply a determination of the unknown constant involved. We can calculate the maximum temperature reached by different masses; for example, a star must have at least ¼ the mass of the sun in order to reach the lowest spectral type, M; and in order to reach the hottest type, B, it must be at least 2½ times as massive as the sun. Happily for the

[1] *E.g.* for iron non-ionised the theoretical scattering is 5·2, against an astronomical value 120. If 16 electrons (2 rings) are broken off, the theoretical coefficient is 0·9, against an astronomical value 35. For different assumptions as to ionisation the values chase one another, but cannot be brought within reasonable range.

theory, no star has yet been found with a mass less than 1/[illegible] of the sun's; and it is a well-known fact, discovered from the study of spectroscopic binaries, that the masses of the B stars are large compared with those of other types. Again, it is possible to calculate the difference of brightness of the giant and dwarf stars of type M, *i.e.* at the beginning and end of their career; the result agrees closely with the observed difference. In the case of a class of variable stars in which the light changes seem to depend on a mechanical pulsation of the star, the knowledge we have obtained of the internal conditions enables us to predict the period of pulsation within narrow limits. For example, for δ Cephei, the best-known star of this kind, the theoretical period is between four and ten days, and the actual period is $5\frac{1}{3}$ days. Corresponding agreement is found in all the other cases tested.

Our observational knowledge of the things here discussed is chiefly of a rather vague kind, and we can scarcely claim more than a general agreement of theory and observation. What we have been able to do in the way of tests is to offer the theory a considerable number of opportunities to "make a fool of itself," and so far it has not fallen into our traps. When the theory tells us that a star having the mass of the sun will at one stage in its career reach a maximum effective temperature of 9000° (the sun's effective temperature being 6000°) we cannot do much in the way of checking it; but an erroneous theory might well have said that the maximum temperature was 20,000° (hotter than any known star), in which case we should have detected its error. If we cannot feel confident that the answers of the theory are true, it must be admitted that it has shown some discretion in lying without being found out.

It would not be surprising if individual stars occasionally depart considerably from the calculated results, because at present no serious attempt has been made to take into account rotation, which may modify the conditions when sufficiently rapid. That appears to be the next step needed for a more exact study of the question.

Probably the greatest need of stellar astronomy at the present day, in order to make sure that our theoretical deductions are starting on the right lines, is some means of measuring the apparent angular diameters of stars. At present we can calculate them approximately from theory, but there is no observational check. We believe we know with fair accuracy the apparent surface brightness corresponding to each spectral type; then all that is necessary is to divide the total apparent brightness by this surface brightness, and the result is the angular area subtended by the star. The unknown distance is not involved, because surface brightness is independent of distance. Thus the estimation of the angular diameter of any star seems to be a very simple matter. For instance, the star with the greatest apparent diameter is almost certainly Betelgeuse, diameter 0·051″. Next to it comes Antares, 0·043″. Other examples are Aldebaran 0·022″, Arcturus 0·020″, Pollux 0·013″. Sirius comes rather low down with diameter 0·007″. The following table may be of interest as showing the angular diameters expected for stars of various types and visual magnitudes:—

Probable Angular Diameters of Stars.

Vis. Mag.	A	F	G	K	M
m	″	″	″	″	″
0·0	0·0034	0·0054	0·0098	0·0219	0·0859
2·0	0·0014	0·0022	0·0039	0·0087	0·0342
4·0	0·0005	0·0009	0·0016	0·0035	0·0136

However confidently we may believe in these values, it would be an immense advantage to have this first step in our deductions placed beyond doubt. If the direct measurement of these diameters could be made with any accuracy it would make a wonderfully rapid advance in our knowledge. The prospects of accomplishing some part of this task are now quite hopeful. We have learnt with great interest this year that work is being carried out by interferometer methods with the 100-in. reflector at Mount Wilson, and the results are most promising. At present the method has been applied only to measuring the separation of close double stars, but there seems to be no doubt that an angular diameter of 0·05″ is well within reach. Although the great mirror is used for convenience, the interferometer method does not in principle require great apertures, but rather two small apertures widely separated, as in a range-finder. Prof. Hale has stated, moreover, that successful results were obtained on nights of poor seeing. Perhaps it would be unsafe to assume that "poor seeing" at Mount Wilson means quite the same thing as it does for us, and I anticipate that atmospheric disturbance will ultimately set the limit to what can be accomplished. But even if we have to send special expeditions to the top of one of the highest mountains in the world, the attack on this far-reaching problem must not be allowed to languish.

I spoke earlier of the radiation-pressure exerted by the outflowing heat, which has an important effect on the equilibrium of a star. It is quite easy to calculate what proportion of the weight of the material is supported in this way; it depends on neither the density nor the opacity, but solely on the star's total mass and on the molecular weight. No astronomical data are needed; the calculation involves only fundamental physical constants found by laboratory researches. Here are the figures, first for average molecular weight 3·0:—

> For mass $\frac{1}{3}$ × sun, fraction of weight supported by radiation-pressure = 0·044.
>
> For mass 5 × sun, fraction of weight supported by radiation-pressure = 0·457.

For molecular weight 5·0 the corresponding fractions are 0·182 and 0·645.

The molecular weight can scarcely go beyond this range,[2] and for the conclusions I am about to draw it does not much matter which limit we take. Probably 90 per cent. of the giant stars have masses between $\frac{1}{3}$ and 5 times the sun's, and we see that this is just the range in which radiation-pressure rises from unimportance to importance. It seems clear that a globe of gas of larger mass, in which radiation-pressure and gravitation are nearly balancing, would be likely to be unstable. The condition may not be strictly unstable in itself, but a small rotation or perturbation would make it so. It may therefore be conjectured that, if nebulous material began to concentrate into a mass much greater than five times the sun's, it would probably break up, and continue to redivide until more stable masses resulted. Above the upper limit the chances of survival are small; when the lower limit is approached the danger has practically disappeared, and there is little likelihood of any further breaking-up. Thus the final masses are left distributed almost entirely between the limits given. To put the matter slightly differently, we are able to predict from general principles that the material of the stellar universe will aggregate primarily into masses chiefly lying between 10^{33} and 10^{34} grams; and this is just the

[2] As an illustration of these limits, iron has 26 outer electrons; if 10 break away the average molecular weight is 5; if 18 break away the molecular weight is 3. Eggert (*Phys. Zeits.*, 1019, p. 570) has suggested by thermodynamical reasoning that in most cases the two outer rings (16 electrons) would break away in the stars. The comparison of theory and observation for the dwarf stars also points to a molecular weight a little greater than 3.

magnitude of the masses of the stars according to astronomical observation.[3]

This study of the radiation and internal conditions of a star brings forward very pressingly a problem often debated in this Section: What is the source of the heat which the sun and stars are continually squandering? The answer given is almost unanimous —that it is obtained from the gravitational energy converted as the star steadily contracts. But almost as unanimously this answer is ignored in its practical consequences. Lord Kelvin showed that this hypothesis, due to Helmholtz, necessarily dates the birth of the sun about 20,000,000 years ago; and he made strenuous efforts to induce geologists and biologists to accommodate their demands to this time-scale. I do not think they proved altogether tractable. But it is among his own colleagues, physicists and astronomers, that the most outrageous violations of this limit have prevailed. I need only refer to Sir George Darwin's theory of the earth-moon system, to the present Lord Rayleigh's determination of the age of terrestrial rocks from occluded helium, and to all modern discussions of the statistical equilibrium of the stellar system. No one seems to have any hesitation, if it suits him, in carrying back the history of the earth long before the supposed date of formation of the solar system; and, in some cases at least, this appears to be justified by experimental evidence which it is difficult to dispute. Lord Kelvin's date of the creation of the sun is treated with no more respect than Archbishop Ussher's.

The serious consequences of this contraction hypothesis are particularly prominent in the case of giant stars, for the giants are prodigal with their heat and radiate at least a hundred times as fast as the sun. The supply of energy which suffices to maintain the sun for 10,000,000 years would be squandered by a giant star in less than 100,000 years. The whole evolution in the giant stage would have to be very rapid. In 18,000 years at the most a typical star must pass from the initial M stage to type G. In 80,000 years it has reached type A, near the top of the scale, and is about to start on the downward path. Even these figures are probably very much over-estimated.[4] Most of the naked-eye stars are still in the giant stage. Dare we believe that they were all formed within the last 80,000 years? The telescope reveals to us objects remote not only in distance, but also in time. We can turn it on a globular cluster and behold what was passing 20,000, 50,000, even 200,000 years ago unfortunately not all in the same cluster, but in different clusters representing different epochs of the past. As Shapley has pointed out, the verdict appears to be "no change." This is perhaps not conclusive, because it does not follow that individual stars have suffered no change in the interval; but it is difficult to resist the impression that the evolution of the stellar universe proceeds at a slow, majestic pace, with respect to which these periods of time are insignificant.

There is another line of astronomical evidence which appears to show more definitely that the evolution of the stars proceeds far more slowly than the contraction hypothesis allows; and perhaps it may ultimately enable us to measure the true rate of progress. There are certain stars, known as Cepheid variables, which undergo a regular fluctuation of light of a characteristic kind, generally with a period of a few days. This light change is *not* due to eclipse. Moreover, the colour quality of the light changes between maximum and minimum, evidently pointing to a periodic change in the physical condition of the star. Although these objects were formerly thought to be double stars, it now seems clear that this was a misinterpretation of the spectroscopic evidence. There is, in fact, no room for the hypothetical companion star; the orbit is so small that we should have to place it inside the principal star. Everything points to the period of the light pulsation being something intrinsic in the star; and the hypothesis advocated by Shapley, that it represents a mechanical pulsation of the star, seems to be the most plausible. I have already mentioned that the observed period does, in fact, agree with the calculated period of mechanical pulsation, so that the pulsation explanation survives one fairly stringent test. But whatever the cause of the variability, whether pulsation or rotation, provided only that it is intrinsic in the star, and not forced from outside, the density must be the leading factor in determining the period. If the star is contracting so that its density changes appreciably, the period cannot remain constant. Now, on the contraction hypothesis the change of density must amount to at least 1 per cent. in forty years. (I give the figures for δ Cephei, the best-known variable of this class.) The corresponding change of period should be very easily detectable. For δ Cephei the period ought to decrease 40 seconds annually.

Now δ Cephei has been under careful observation since 1785, and it is known that the change of period, if any, must be very small. S. Chandler found a decrease of period of $\frac{1}{20}$ second per annum, and in a recent investigation E. Hertzsprung has found a decrease of $\frac{1}{10}$ second per annum. The evidence that there is any decrease at all rests almost entirely on the earliest observations made before 1800, so that it is not very certain; but in any case the evolution is proceeding at not more than $\frac{1}{400}$ of the rate required by the contraction hypothesis. There must at this stage of the evolution of the star be some other source of energy which prolongs the life of the star 400-fold. The time-scale so enlarged would suffice for practically all reasonable demands.

I hope the dilemma is plain. Either we must admit that whilst the density changes 1 per cent. a certain period intrinsic in the star can change no more than $\frac{1}{400}$ of 1 per cent., or we must give up the contraction hypothesis.

If the contraction theory were proposed to-day as a novel hypothesis I do not think it would stand the smallest chance of acceptance. From all sides—biology, geology, physics, astronomy—it would be objected that the suggested source of energy was hopelessly inadequate to provide the heat spent during the necessary time of evolution; and, so far as it is possible to interpret observational evidence confidently, the theory would be held to be negatived definitely. Only the inertia of tradition keeps the contraction hypothesis alive—or, rather, not alive, but an unburied corpse. But if we decide to inter the corpse, let us frankly recognise the position in which we are left. A star is drawing on some vast reservoir of energy by means unknown to us. This reservoir can scarcely be other than the sub-atomic energy which, it is known, exists abundantly in all matter; we sometimes dream that man will one day learn how to release it and use it for his service. The store is well-nigh inexhaustible, if only it could be tapped. There is sufficient in the sun to maintain its output of heat for 15 billion years.

Certain physical investigations in the past year, which I hope we may hear about at this meeting, make it probable to my mind that some portion of this

[3] By admitting plausible assumptions closer limits could be drawn. Taking the molecular weight as 3·5, and assuming that the most critical condition is when $\frac{1}{4}$ of gravitation is counterbalanced (by analogy with the case of rotating spheroids, in which centrifugal force opposes gravitation and creates instability), we find that the critical mass is just twice that of the sun, and stellar masses may be expected to cluster closely round this value.

[4] I have taken the ratio of specific heats at the extreme possible value, $\frac{5}{3}$; that is to say, no allowance has been made for the energy needed for ionisation and internal vibrations of the atoms, which makes a further call on the scanty supply available.

sub-atomic energy is actually being set free in the stars. F. W. Aston's experiments seem to leave no room for doubt that all the elements are constituted out of hydrogen atoms bound together with negative electrons. The nucleus of the helium atom, for example, consists of four hydrogen atoms bound with two electrons. But Aston has further shown conclusively that the mass of the helium atom is less than the sum of the masses of the four hydrogen atoms which enter into it; and in this, at any rate, the chemists agree with him. There is a loss of mass in the synthesis amounting to about 1 part in 120, the atomic weight of hydrogen being 1·008 and that of helium just 4. I will not dwell on his beautiful proof of this, as you will, no doubt, be able to hear it from himself. Now mass cannot be annihilated, and the deficit can only represent the mass of the electrical energy set free in the transmutation. We can therefore at once calculate the quantity of energy liberated when helium is made out of hydrogen. If 5 per cent. of a star's mass consists initially of hydrogen atoms, which are gradually being combined to form more complex elements, the total heat liberated will more than suffice for our demands, and we need look no further for the source of a star's energy.

But is it possible to admit that such a transmutation is occurring? It is difficult to assert, but perhaps more difficult to deny, that this is going on. Sir Ernest Rutherford has recently been breaking down the atoms of oxygen and nitrogen, driving out an isotope of helium from them; and what is possible in the Cavendish Laboratory may not be too difficult in the sun. I think that the suspicion has been generally entertained that the stars are the crucibles in which the lighter atoms which abound in the nebulæ are compounded into more complex elements. In the stars matter has its preliminary brewing to prepare the greater variety of elements which are needed for a world of life. The radio-active elements must have been formed at no very distant date; and their synthesis, unlike the generation of helium from hydrogen, is endothermic. If combinations requiring the addition of energy can occur in the stars, combinations which liberate energy ought not to be impossible.

We need not bind ourselves to the formation of helium from hydrogen as the sole reaction which supplies the energy, although it would seem that the further stages in building up the elements involve much less liberation, and sometimes even absorption, of energy. It is a question of accurate measurement of the deviations of atomic weights from integers, and up to the present hydrogen is the only element for which Dr. Aston has been able to detect the deviation. No doubt we shall learn more about the possibilities in due time. The position may be summarised in these terms: the atoms of all elements are built of hydrogen atoms bound together, and presumably have at one time been formed from hydrogen; the interior of a star seems as likely a place as any for the evolution to have occurred; whenever it did occur a great amount of energy must have been set free; in a star a vast quantity of energy is being set free which is hitherto unaccounted for. You may draw a conclusion if you like.

If, indeed, the sub-atomic energy in the stars is being freely used to maintain their great furnaces, it seems to bring a little nearer to fulfilment our dream of controlling this latent power for the well-being of the human race—or for its suicide.

So far as the immediate needs of astronomy are concerned, it is not of any great consequence whether in this suggestion we have actually laid a finger on the true source of the heat. It is sufficient if the discussion opens our eyes to the wider possibilities. We can get rid of the obsession that there is no other conceivable supply besides contraction, but we need not again cramp ourselves by adopting prematurely what is perhaps a still wilder guess. Rather we should admit that the source is not certainly known, and seek for any possible astronomical evidence which may help to define its necessary character. One piece of evidence of this kind may be worth mentioning. It seems clear that it must be the high temperature inside the stars which determines the liberation of energy, as H. N. Russell has pointed out (Pubns. Ast. Soc. Pacific, August, 1919). If so, the supply may come mainly from the hottest region at the centre. I have already stated that the general uniformity of the opacity of the stars is much more easily intelligible if it depends on scattering rather than on true absorption; but it did not seem possible to reconcile the deduced stellar opacity with the theoretical scattering coefficient. Within reasonable limits it makes no great difference in our calculations at what parts of the star the heat energy is supplied, and it was assumed that it comes more or less evenly from all parts, as would be the case on the contraction theory. The possibility was scarcely contemplated that the energy is supplied entirely in a restricted region round the centre. Now, the more concentrated the supply, the lower is the opacity requisite to account for the observed radiation. I have not made any detailed calculations, but it seems possible that for a sufficiently concentrated source the deduced and the theoretical coefficients could be made to agree, and there does not seem to be any other way of accomplishing this. Conversely, we might perhaps argue that the present discrepancy of the coefficients shows that the energy supply is not spread out in the way required by the contraction hypothesis, but belongs to some new source available only at the hottest, central part of the star.

I should not be surprised if it is whispered that this address has at times verged on being a little bit speculative; perhaps some outspoken friend may bluntly say that it has been highly speculative from beginning to end. I wonder what is the touchstone by which we may test the legitimate development of scientific theory and reject the idly speculative. We all know of theories which the scientific mind instinctively rejects as fruitless guesses; but it is difficult to specify their exact defect or to supply a rule which will show us when we ourselves do err. It is often supposed that to speculate and to make hypotheses are the same thing; but more often they are opposed. It is when we let our thoughts stray outside venerable, but sometimes insecure, hypotheses that we are said to speculate. Hypothesis limits speculation. Moreover, distrust of speculation often serves as a cover for loose thinking; wild ideas take anchorage in our minds and influence our outlook; whilst it is considered too speculative to subject them to the scientific scrutiny which would exorcise them.

If we are not content with the dull accumulation of experimental facts, if we make any deductions or generalisations, if we seek for any theory to guide us, some degree of speculation cannot be avoided. Some will prefer to take the interpretation which seems to be indicated most immediately and at once adopt that as an hypothesis; others will rather seek to explore and classify the widest possibilities which are not definitely inconsistent with the facts. Either choice has it dangers: the first may be too narrow a view and lead progress into a cul-de-sac; the second may be so broad that it is useless as a guide, and diverges indefinitely from experimental knowledge. When this last case happens, it must be concluded that the knowledge is not yet ripe for theoretical treatment and that speculation is premature. The time when speculative theory and observational research may profitably go hand in hand is when the possibilities, or at any rate the probabilities, can be narrowed down by experiment, and the theory can indicate the tests by which the remaining wrong paths may be blocked up one by one.

The mathematical physicist is in a position of peculiar difficulty. He may work out the behaviour of an ideal model of material with specifically defined properties, obeying mathematically exact laws, and so far his work is unimpeachable. It is no more speculative than the binomial theorem. But when he claims a serious interest for his toy, when he suggests that his model is like something going on in Nature, he inevitably begins to speculate. Is the actual body really like the ideal model? May not other unknown conditions intervene? He cannot be sure, but he cannot suppress the comparison; for it is by looking continually to Nature that he is guided in his choice of a subject. A common fault, to which he must often plead guilty, is to use for the comparison data over which the more experienced observer shakes his head; they are too insecure to build extensively upon. Yet even in this, theory may help observation by showing the kind of data which it is especially important to improve.

I think that the more idle kinds of speculation will be avoided if the investigation is conducted from the right point of view. When the properties of an ideal model have been worked out by rigorous mathematics, all the underlying assumptions being clearly understood, then it becomes possible to say that such-and-such properties and laws lead precisely to such-and-such effects. If any other disregarded factors are present, they should now betray themselves when a comparison is made with Nature. There is no need for disappointment at the failure of the model to give perfect agreement with observation; it has served its purpose, for it has distinguished what are the features of the actual phenomena which require new conditions for their explanation. A general preliminary agreement with observation is necessary, otherwise the model is hopeless; not that it is necessarily wrong so far as it goes, but it has evidently put the less essential properties foremost. We have been pulling at the wrong end of the tangle, which has to be unravelled by a different approach. But after a general agreement with observation is established, and the tangle begins to loosen, we should always make ready for the next knot. I suppose that the applied mathematician whose theory has just passed one still more stringent test by observation ought not to feel satisfaction, but rather disappointment—"Foiled again! This time I *had* hoped to find a discordance which would throw light on the points where my model could be improved." Perhaps that is a counsel of perfection; I own that I have never felt very keenly a disappointment of this kind.

Our model of Nature should not be like a building—a handsome structure for the populace to admire, until in the course of time someone takes away a corner-stone and the edifice comes toppling down. It should be like an engine with movable parts. We need not fix the position of any one lever; that is to be adjusted from time to time as the latest observations indicate. The aim of the theorist is to know the train of wheels which the lever sets in motion—that binding of the parts which is the soul of the engine.

In ancient days two aviators procured to themselves wings. Dædalus flew safely through the middle air across the sea, and was duly honoured on his landing. Young Icarus soared upwards towards the sun until the wax which bound his wings melted, and his flight ended in fiasco. In weighing their achievements perhaps there is something to be said for Icarus. The classic authorities tell us that he was only "doing a stunt," but I prefer to think of him as the man who certainly brought to light a constructional defect in the flying-machines of his day. So, too, in science. Cautious Dædalus will apply his theories where he feels most confident they will safely go; but by his excess of caution their hidden weaknesses cannot be brought to light. Icarus will strain his theories to the breaking-point until the weak joints gape. For a spectacular stunt? Perhaps partly; he is often very human. But if he is not yet destined to reach the sun and solve for all time the riddle of its constitution, yet he may hope to learn from his journey some hints to build a better machine.

Memorial Tributes to Sir Norman Lockyer.

IN Sir Norman Lockyer the country loses one of the most ardent supporters of science in his time. As one who enjoyed his intimate friendship for more than half a century, I would fain add my personal contribution to the many expressions of regret and appreciation which the loss is sure to call forth.

There never was a man more thoroughly imbued than he with a sense of the importance of the cultivation of science, not only for its own sake, but also for the multitude of ways in which it may be made to minister to the welfare of mankind. Though he had made choice of astronomy as his own field of work, he was no mere specialist, but kept his sympathy in touch with the progress of science as a whole, and worked, harder than most of his contemporaries knew, to further that progress. Sir Norman's younger years as a clerk in the War Office, while affording him an insight into the methods of a Government Department, furnished also a training in business habits which served him in good stead through later life. The secretaryship of the Duke of Devonshire's Commission on scientific instruction, to which as a young man he was appointed, undoubtedly gave the impetus that made him so strenuous an advocate of a wider recognition of the claims of science for a place in our educational and industrial organisation. This appointment, by bringing him into personal acquaintance with the leading men of science of the day, strengthened and widened his sympathies. One of the first results of the experience thus gained was to convince him of the need for better teaching of the rudiments of science in our schools. He saw that one of the first requirements was the production of simple elementary treatises on the different departments of natural knowledge, written not by mere book-makers, but by the best living authorities on the several subjects. He confided to me the scheme which he drew up, and asked me to co-operate with him. It so happened that a similar proposal was about the same time laid before Mr. Alexander Macmillan, head of the publishing firm, by Profs. Huxley, Balfour Stewart, and Roscoe. It was finally arranged that the scheme of these eminent professors should be adopted, and that Lockyer and I should contribute to it. In this way arose the series of elementary text-books or Primers, of which millions of copies have been sold, some of them having been translated into most of the languages of Europe and into some of those of Asia.

Sir Norman's energy also led him to project a weekly journal entirely devoted to science. He convinced the same enterprising publisher that such a journal would be of much value in chronicling for the general public the progress of scientific opinion and discovery. Thus the present publication came into existence. Lockyer was, of course, its editor, and he continued to fill the editorial chair with amazing industry and success for fifty years. It would be difficult to appraise the value of this service to the cause of science. But the historian of the future, when he comes to describe the various influences which have fostered that cause in this country since 1870, will not forget to include Sir Norman and NATURE.

My old friend's enthusiasm spurred him to take part in a long succession of solar eclipse expeditions, which took him into remote parts of the world, and sometimes involved no little risk. These foreign journeys he continued to undertake until he was not far from seventy years of age.

Sir Norman Lockyer's many communications to the Royal Society and other learned bodies, and also the array of his separately published volumes, form the best monument of his life-work. Those who knew him best often wondered how, with only one serviceable eye, he could get through the amount of telescopic and spectroscopic work which he accomplished. His personal charm was great. The kindly nature, ready helpfulness, and infectious enthusiasm that were so characteristic of him endeared him to those who had the privilege of his friendship, and who feel that he leaves a vacant place among the men of science in this country which it will be hard to fill as he filled it.

ARCH. GEIKIE.

WITH the death, at an advanced age, of Joseph Norman Lockyer, a remarkable and in some respects unique personality passes away from the English scientific world. It would be unnecessary for me, even if I were competent, to describe the progress and achievements of his work in science; that has been done already in these pages; nor need I dwell on merely biographical detail. I have been invited to write an appreciation of Lockyer. I can only respond by giving my impression of the man drawn from tolerably close intimacy in an acquaintanceship extending over half a century. Some biographical detail is a necessary framework.

Lockyer's education, though doubtless sufficient, seems to have been unsystematic; part was obtained on the Continent, where he attended lectures at the Sorbonne. He did not receive the training either of a public school or of a university; he started in life unhampered by any educational shibboleths or the acquirement of academic status. This was amply made up to him in after-life, for it is more than doubtful if any contemporary man of science had more honorary degrees showered upon him. Lockyer's father was a man of scientific occupation and probably of some attainment; the son evidently received from him an impulse towards science which no schooling in the early half of the last century could have supplied.

At the age of twenty-one Lockyer was appointed to a clerkship in the War Office; there he remained for thirteen years. Hundreds of young men in such a position have merely matured or withered towards a pension. From that fate he was preserved by the tumultuous energy which characterised him all through life. In the face of opposition he carried out internal administrative reforms in the Office, and had his reward in 1865 in being appointed by Lord de Grey editor of the Army Regulations. I remember his telling me that their codification cost him two years' work, and that the strain of having to carry in his head for the purpose a vast mass of detail almost broke him down. It seems almost incredible that, apart from his official life, he was able to carry on successful astronomical research. He was elected to the Royal Astronomical Society in 1860, and in 1866 devised a method of observing the solar prominences without an eclipse; this was afterwards applied by Janssen and himself, and commemorated in a medal by the French Government. In 1868 he discovered in the sun helium, then unknown as a terrestrial element. In 1869, while still in the War Office, he was elected into the Royal Society.

With such a record of administrative and scientific ability it is not surprising to find Lockyer in the following year appointed secretary of the Royal Commission on Scientific Instruction. At its conclusion Disraeli transferred him to the Science and Art Department, for which he organised the extremely successful Loan Exhibition of Scientific Apparatus opened by Queen Victoria in 1876. In 1881 he became professor of astronomical physics in the Royal College of Science. Research into solar phenomena now became the dominant purpose of his life; it led him into fertile speculations in various directions. They engaged him to the last, and but a year ago he contributed a paper to this journal. The earliest was the correlation between climate and solar activity. I well remember the cold douche he administered when he pointed out to me that its effect, far from being direct, might be the reverse. The importance of this principle, which at the time seemed paradoxical, has now become fundamental in meteorological research; regions are now known to be affected oppositely by changes in the sun's heat supply. Lockyer was chief of eight Government eclipse expeditions in which a brief examination of the isolated chromosphere became possible. In these he had the assistance of the Navy, and their success was due not only to his capacity for leadership and organisation, but also to his ability to inspire interest and enthusiasm in the work in both officers and bluejackets. The installation of a temporary observatory in some remote and uninhabited spot was not seldom difficult.

In 1869 Lockyer and Alexander Macmillan founded NATURE; English science in other respects owes much to the latter and his successors. Henry Woodward, who is still with us, was present at a dinner at the Garrick Club to celebrate its birth. It needed a good send-off, for Sir H. Trueman Wood thought that at the time it "can scarcely have been regarded as a very promising speculation." Probably it was not, but both founders—and Lockyer the most—had a different aim. It may be permitted to quote from the present Vice-Chancellor of the University of Leeds a record of how it has been attained:—"The exacting care with which it has been edited, the impartiality and precision of its judgments, the wide range of its information, the accuracy of its reports, have given NATURE in its own sphere unique distinction and authority."

As to the first, I remember hearing from a distinguished man of science that at a dinner party at which both he and Lockyer were guests, the latter received an urgent printer's proof in the middle of dinner and corrected it then and there.

Lockyer's service with the Commission on Scientific Instruction gave him a thorough insight into the resources, or rather lack of them, throughout the country. It is certainly true, as the present Vice-Principal of Birmingham University tells us, that through the columns of NATURE "there has appeared an informed and helpful criticism that has furthered university growth and development." The criticism was sometimes pretty vigorous. Henry Smith, at Oxford, himself a mathematician of European fame, thought that the editor rather trespassed on the creative function of the Author of Nature.

At Oxford Henry Acland had devoted the best years of his life to getting biology and chemistry admitted to the medical curriculum. Tireless energy with "*aeterna mansuetudine*" succeeded not merely in this, but also in the erection of the New Museum, which was opened in 1861. This, with its Venetian gothic and Skidmore ironwork, is a shrine rather than a laboratory. It was, in fact, an outcome of the Oxford æsthetic renaissance, which in turn owed its filiation to the "Oxford movement." So far science was in the best of company with Dr. Pusey in its support. But Acland really only wanted biology and chemistry for his medical school; accordingly we find in the New Museum Rolleston overtaxing his strength in the attempt to cover the whole biological field; Brodie, emancipated from the cellar of the Ashmolean, treating inorganic chemistry with originality and freshness; and Vernon Harcourt working at chemical change in a reproduction of the Glastonbury kitchen. This was excellent, but unfortunately it was all. As to the rest of the science faculty, some never lectured, some were physically incapacitated, some were frankly non-resident. Much has changed since; new professorships have been founded and entrusted to men of assured accomplishment; new laboratories have been built; and the present Vice-Chancellor finds it convenient occasionally to borrow a number of NATURE to verify an appointment.

At Cambridge we have the testimony of Dr. Glaisher as to "the almost complete lack of interest in natural science that existed in the university when NATURE was founded"; even in mathematics "there was no encouragement—quite the reverse—to research of any kind." To the "great expansion of thought, study, and learning" that has taken place since, "NATURE has largely and worthily contributed."

These testimonials, borrowed from the record on the occasion of last year's jubilee, acquire a true significance when we read in them LOCKYER for NATURE. He never ceased to insist on the necessity of combining university teaching with research. He displeased the somnolent, and still more when he supported a better distribution of available funds in which the untimely death of Dr. Appleton deprived him of support from the side of the "humanities." He was in no way deterred by the sarcasm of Henry Smith and Sir John Evans—who ought to have known better—that the endowment of research only camouflaged—to use the phrase of the day—the research for endowment.

We may congratulate ourselves with Sir Donald MacAlister that NATURE "still informs, chastens, and stimulates the scientific worker and the scientific teacher." Chastening is now seldom called for, but in the early days it was vigorously applied. Teaching and text-books were largely obsolete, and received criticism that was often ruthless. Controversies in its pages were sometimes fierce; they cleared things up, and Lockyer kept the ring with complete impartiality. He would himself submit to a little chastening without ill-will. On one occasion a series of articles was commenced with a general approval from Huxley. But it immediately became apparent that the fundamental assumption was unsound. I sent him a short statement of the fact; he admitted that it was unanswerable, published it, and stopped the series.

If the early days were in some measure marked by storm and stress, Lockyer's transparent sincerity and enthusiasm carried him through. When NATURE had completed its twenty-fifth year the publishers assembled for a dinner at the Savoy Hotel in Lockyer's honour some fifty of the most active and representative of our scientific men then available. Huxley emerged from retirement to be present. With sly humour he hinted at the chastening, and recalled a story of an aggrieved wife who had received some discipline from her husband, but who explained to the magistrate that she "didn't look upon him as a 'usband so much as a friend."

Here I must stop. Otherwise I might touch on Lockyer's kind-heartedness, his capacity for making friends, his courage in family sorrow, his literary labours, and other aspects of a full and many-sided life. I conclude by once more drawing on the jubilee record for the testimony of the Royal Engineers Institute, Chatham, that the Editor of Nature "never failed to enforce the great lesson that the search for knowledge, pursued for its own ends and with no immediate thoughts of material gain, should be one of the most potent driving forces in the life of a nation."

W. T. Thiselton-Dyer.

My acquaintance—and I may add my friendship—with the late Sir Norman Lockyer dates back from almost exactly half a century ago. It began in the autumn of 1870, when the details of the arrangements in connection with the projected Government expedition to observe the total solar eclipse of December 22 of that year were under consideration. Lockyer was then in the full tide of his intellectual vigour. Two years previously he had leaped into fame, and established a commanding position as one of the pioneers of the newly developed domain of solar physics, by his memorable discovery, made simultaneously with, but independently of, Janssen, of a spectroscopic method of observing, delineating, and analysing the chromosphere at any time the sun is unobscured. In conjunction with Frankland he had detected the existence of a new element in the solar atmosphere named by the discoverers "helium," which Ramsay and others, twenty-seven years later, proved to be present in many terrestrial rocks and minerals, and to occur among the gases evolved from springs. Helium, in fact, has been shown to be a widely distributed element, and to be capable of useful application. But with its singular properties, its origin and mode of genesis, and its relations to other "elements," we are not now concerned. The immediate point is that these two cardinal discoveries, with which Lockyer's name will be associated for all time, rendered it a matter of national honour and obligation that every effort should be made, and no opportunity lost, to follow up the line of inquiry he had initiated.

Even although half a century has elapsed, much of the physical history of the sun can be traced only by the observation and study of the phenomena of a total solar eclipse. In 1870 the present methods of attack were, comparatively speaking, in their infancy. Warren de la Rue first used his photo-heliograph during the eclipse of July 18, 1860. In the same year Bunsen constructed the first spectroscope, which was quickly applied to the examination of celestial objects. Tennant had directed it to the corona of the Indian eclipse of 1868, and Young to that of the eclipse of 1869. But the results were contradictory. Tennant found that the spectrum was the ordinary solar spectrum; Young detected the existence of bright lines, but was uncertain as to whether they might not be due to the outlying and nebulous portion of the chromosphere. To the world of science the question was of the greatest interest. Hence the importance of the eclipse of 1870, which, it was hoped, would settle the matter. Mr. Robert Lowe at that period was Chancellor of the Exchequer, but, even if he were so minded, the Government was unable to resist the appeal of the Royal and Royal Astronomical Societies that properly equipped expeditions should be sent to suitable places along the central line of totality. Lockyer was by common consent designated as a leader of one of the parties. With characteristic zeal and ardour he threw himself heartily into the work of organisation. Arrangements were made to observe at various stations along the eastern coast of Sicily. He elaborated a comprehensive plan of observation, mainly directed to the elucidation of the structure and physical nature of the corona, and secured the co-operation of competent physicists and trained observers. Unfortunately, all his forethought, labour, and anxiety came to nothing. The Admiralty dispatch-boat *Psyche*, conveying the party from Naples to Catania, struck a submerged rock near Aci Reale. All on board were safely put on shore, and so, ultimately, were the instruments, but the poor dispatch-boat became a total loss. It was characteristic of Lockyer, whose whole thought was concentrated on the work he had undertaken, that he should have telegraphed home as soon as he reached Catania:—"*Psyche* totally wrecked. Instruments saved." Anxious relatives might infer the rest as they pleased.

Misfortune, however, still followed us. We managed to get everything in readiness for the eventful day, but as the total phase approached, the rapid fall of temperature occasioned the formation of cloud; the corona was wholly obscured, and no spectroscopic or other observations during totality were possible, and photographic exposures were useless. The work entrusted to me consisted in determining the photometric intensity of the solar light during the progress of the eclipse, and was independent of the total phase. Fortunately, I was able to obtain a complete set of measurements, which afterwards found their way into one of the publications of the Royal Society. But our philosophy was sorely exercised on learning that a perfect view of the unclouded corona was obtained from the deck of the wrecked *Psyche* some few miles away. The greatest sympathy was felt by everybody for Lockyer, and his disappointment was naturally very keen. But he bore it stoically; if he had not secured success, he had at least deserved it. Of the band of observers associated with him—among them Sir Henry Roscoe, Sir George Darwin, W. K. Clifford, W. G. Adams, Ranyard, John Brett, the artist, Sir Alexander Pedler, Brothers, Bowen, and Seabroke—I believe I am now the sole survivor.

I was a member of another expedition of which Lockyer was the leader—viz. that sent to the island of Granada, in the West Indies, to observe the total solar eclipse of August 29, 1886, when we were generally more fortunate, good observations being made by the late Father Perry, S.J., at Carriacou, Prof. Turner, Savilian professor at Oxford, Sir Arthur Schuster, and Major Darwin. Lockyer was not in good health at the time, and appeared to suffer from the heat and humidity of the climate.

On my translation to the Normal School of Science, South Kensington, as successor to Sir Edward Frankland, I became closely associated with Lockyer as a member of the teaching staff. He lectured on solar physics, and directed the observatory then standing near the western side of Exhibition Road. His laboratory and private room were in the main building close to the chemical laboratories, and I naturally saw much of him at this period. He was an indefatigable experimenter, and I was not infrequently called upon to see his results. He was always ready to discuss his work with anybody who showed an interest in it, and never made the slightest secret of what he was doing and why he was doing it. He was fertile in ideas and prolific in working hypotheses, which were discarded as readily as they were formed if found barren of results. No man ever made a greater scientific use of the imagination, and at times, in the course of conversation, he seemed to give the loosest possible rein to his fancy. Much of his routine observatory work was, of course, done by assistants, by whom he was well served. But he took a very active part in the work of the laboratory, and generally made the crucial observations himself, or assured himself of their validity by repetition. He was an excellent teacher, with a remarkable gift of exposition. He spoke fluently, with a ready command of apt expression and telling phrase, and he had no difficulty in retaining the attention of any audience he addressed. At one period of his career he was in great request as a popular lecturer, and undoubtedly did much to arouse interest and disseminate information concerning celestial phenomena, especially in connection with solar chemistry and physics. He had little opportunity of creating a "school." The primary duty of the Normal School of Science, or, as it was afterwards called, the Royal College of Science, was to train science-teachers, and the subjects of his chair offered little promise of a lucrative career.

He was a loyal colleague, and, under Huxley's wise direction as Dean, took his fair share in discussion and advice. Of his many social gifts others will no doubt be able to testify. He was fond of the society of his fellows, a genial host, entertaining and hospitable, an excellent conversationalist, with a nimble wit, and an unfailing power of ready repartee. There must be very many who have the pleasantest recollections of the delightful dinner parties in his town house in Penywern Road, and of the conversaziones which usually followed them.

Lockyer early enlisted me into the service of NATURE, and I became a frequent contributor to the journal which, under his judicious and enlightened direction, has done so much to foster and advance the interests of science in this country. My relations with him as the Editor were of the most cordial character, and I collaborated with him occasionally in the production of a leading article. Such work when done in common with him in his sanctum, frequently late at night, necessarily took up much time when protracted, as was usual, by his too ready flow of ideas, which needed a certain power of compression to get them into literary form; and at times it was only in the small hours of the morning that I was able to wend my way home—a not infrequent experience, however, of leader-writers.

It cannot, of course, be maintained that all that Lockyer has published has withstood the test of time. Some of his experimental evidence, and certain of his deductions and generalisations, were hotly challenged at about the time he made them known. But when all is said that can be said in the way of criticism and detraction, it may be confidently asserted that he has left an indelible impress on the scientific history of his epoch. His memory will be cherished by all who have come under his influence, or have learned to appreciate his many excellent qualities of head and heart, and have knowledge of his untiring efforts to serve the highest interests of science.

T. E. THORPE.

I FIRST made the acquaintance of Lockyer in Clifton, where I met him at dinner at the house of the late William Lant Carpenter in or about 1874. Lockyer had come to give a popular lecture in Bristol on his own and other recent discoveries in celestial spectroscopy, and he was full of his new ideas about the origin and nature of the elements. I remember his asking me whether I considered calcium to be an element, and, having been brought up in the then prevalent view of the permanence of the chemical elements, I replied that I should certainly so regard it. The periodic scheme of Mendeléeff was comparatively new, and Mendeléeff himself did not encourage the notion that it involved the question of the origin of the elements. Lockyer was the first to pursue the subject systematically, and much of his astrophysical research was directed towards establishing his ideas as to the dissociation of the terrestrial elements in the hottest of the stars.

I also remember coming into contact with Lockyer at the time when he was secretary of the Duke of Devonshire's Commission on Scientific Instruction, in the operations of which I was, of course, deeply interested, owing to the position I held as senior science master in Clifton College. I never at that time could have expected to be thrown into daily communication with him, as I was twenty years later, owing to an arrangement with Frankland, then professor of chemistry in the Royal College of Science at South Kensington. Frankland and Lockyer had in 1869 been engaged in joint researches on the "Physical Constitution of the Sun," and when in 1881 Lockyer became professor of astrophysics at the Royal

College of Science he secured the use of a room in the new building to which access was obtainable only through the two intermediate rooms occupied by Frankland and his successors as the research laboratory for chemistry. The consequence was that the professor of astrophysics and his satellites were compelled to pass many times in the day through the chemical rooms. It cannot be said that this was an advantage to the chemical work, for, owing to draughts and general disturbance, some chemical operations were absolutely prohibited; but the arrangement had one compensation in the opportunities afforded of frequent talk with the professor, and of hearing from him what was going on. Lockyer was always very helpful to other less experienced workers with the spectroscope, and after the discovery by Ramsay of terrestrial helium it can be readily imagined what a bustle arose in the room occupied by the professor of astrophysics, to whom the original observation of the same element in the sun was due. This naturally gave rise to many conferences with the professor of chemistry on the subject of the minerals from which the gas was obtained.

Lockyer was also a genial and jovial member of the circle which assembled daily round the luncheon table in the museum, which included in later years some of the professors from the City and Guilds Central College. Nearly all are now gone, and only memories remain to the few survivors. Those recollections include the conviction that Lockyer was a strong man who always knew his own mind, and hence accomplished much both by practice and example where lesser men, though with the same aspirations, only met with failure and disappointment. William A. Tilden.

The privilege of taking part in the memorial tributes to Sir Norman Lockyer is perhaps something more than I deserve, for, although it is true we were on terms of cordial friendship, we were never associated in official or scientific occupations, unless his invitation to join in the founding of the British Science Guild, and his many courtesies as Editor of Nature, may be so described. To speak of Lockyer's researches as contributions to science seems inadequate. Incapable as I was of following his scientific work in detail, I felt it to be more than contributory; we admired him rather as a builder, and a builder on big and original lines. There was something large in his undertakings and in his vision, and happily to sustain them he had also within him a fountain of energy which seemed perennial. His prescience and his vigour together were enormous, and carried him into many spheres of activity. If sometimes I was tempted to grudge his spending in the clouds what was needed by mankind, this was ungrateful, for Lockyer put his driving power freely into many sublunary affairs.

That Lockyer was disposed to be combative he was the first to admit, but always on liberal and generous lines; and in personal differences he was always kindly and good-humoured. His was the combativeness that keeps societies from stagnation. On two important affairs he and I differed decisively, but always in good temper, and I gladly admit that in the main he was right on both issues. From the time of his departure from London most of us had to lament the loss, not, happily, at the time, of an original worker in science, but of a most ingenious and stimulating companion. At length we have lost a colleague not only a master of minute and diligent observation, but also endowed with that wide and abstract imagination which, if other than the individual imagination of the artist, is no less prophetic in the sphere of science. Clifford Allbutt.

I cannot call myself an intimate friend of the late Sir Norman Lockyer, though we frequently met and talked, but two characteristics in him always impressed me. One was his energy. He seemed always to be at work, always to be full of interests, and whatever he took up he did well. The other was the many-sidedness of his mind, and his power of combining business ability and scientific acuteness. Quite early in his career he made important contributions to solar physics, discovering (with Janssen) how to examine the solar prominences apart from an eclipse, investigated meteors, and was one of the three simultaneously to explain the wonderful glows which followed the Krakatoa eruption. Besides this he wrote valuable and suggestive papers on Stonehenge and other British stone circles. With all this he was a very efficient public servant, both in the War Office and in the Science and Art Department, secretary to the Duke of Devonshire's Commission on Scientific Instruction in 1870, and Editor of Nature for fifty years from its commencement. We shall not readily meet again with his like. T. G. Bonney.

Mr. Arthur Savage writes:—Like many other people, I have been reading the life-story of Sir Norman Lockyer, the great man of science who was able to add so liberal a contribution to the accumulation of human knowledge. I was interested to learn from the obituary notice which appeared in the *Times* of August 17 that Sir Norman was the founder of Nature, and I have thought the opportunity a fitting one to express a young man's humble word of appreciation of your excellent journal.

Although I have not received a university education, and my daily duties are outside the domain of scientific study, you may be glad to know that I follow your columns regularly in order to keep myself "up to date" in matters relating to those branches of knowledge in which I am interested. Should you consider this note worthy of publication I have no doubt that it would represent the feelings of numerous other "ordinary" individuals like myself.

Notes.

WE have received from a correspondent in India a letter which states that the present director of the Indian Institute of Science at Bangalore, Sir Alfred Bourne, is to be succeeded by an administrator with no scientific experience. Such an appointment would be greatly deprecated by scientific workers, and we trust it is not too late to prevent it. In our view the head of such an institution should be a man who combines scientific experience with administrative ability; and if this principle is deliberately ignored in the case of the directorship of the leading scientific institution in India, the strongest protest should be made to the authorities responsible for the appointment.

WHEN Mr. B. B. Woodward retired from the British Museum (Natural History) last June he was still occupied with the proofs of the supplement to his well-known catalogue of the natural history library. Naturalists will be glad to learn that his services have now been temporarily retained for the completion of this valuable work.

WE learn from the *British Medical Journal* for August 28 that the fifth Congress of Physical Therapy, instituted by the Belgian societies of physical therapy and radiology and the Antwerp Association for Physical Therapy, will be held at Antwerp on September 11 and 12; also that the nineteenth Flemish Congress of Medicine and Natural Science will be held at Ghent on September 18 and 19.

THE thirty-first annual general meeting of the Institution of Mining Engineers will be held at Manchester on September 15–17, under the presidency of Col. W. C. Blackett. The institution medal for the year 1919–20 will be presented to Dr. John Bell Simpson, and the following papers will be presented: The Normal Occurrence of Carbon Monoxide in Coal-mines, J. Ivon Graham; The Better Utilisation of Coking Slack, A. E. Beet and A. E. Findley; Richard Trevithick: His Life and Inventions, J. Harvey Trevithick; The Froth Flotation Processes as Applied to the Treatment of Coal, Ernest Bury; and An Improved Method of Determining the Relative Directions of Two Reference Lines or Bases for Mining Surveys, T. Lindsay Galloway.

EARLY last year a Speleological Society was founded in the University of Bristol, and a record of its activities has now been published in the first part of its Proceedings. The society is fortunate in being within easy reach of the Mendip Hills, where so many important caves have already been explored, and it has been able to obtain special facilities for field-work. It has also been favoured with a course of lectures by several leading authorities on prehistoric archæology. In his presidential address Prof. E. Fawcett describes some human skulls found by the society in a cave, associated with Late Palæolithic flint implements and remains of red deer, wild cat, and brown bear. The skulls are both dolichocephalic and brachycephalic, and Prof. Fawcett compares the discovery with one made at Ofnet, near Munich. Mr. L. S. Palmer gives an account of the exploration of another cave, in which numerous Late Celtic objects were found. There are also brief reports of the lectures at the meetings. The society is to be congratulated on its first year's work, and will have the best wishes of all who are interested in the study of early man, but its publication could be improved by more careful editing and by a judicious selection of illustrations produced in better style.

WE have just received from Dr. Hornaday, the director of the New York Zoological Park, a very interesting and important summary of the results of the five-year close season which was deemed necessary in 1912 for the replenishing of the herds of the fur seal of the Pribilof Islands. The results have been everything that the close-season advocates foretold. This conclusion is supported by figures. In 1912 there were 215,738 seals of all ages; in 1917 they had increased to 468,692, and by 1919 these numbers had risen to 530,237. This protection was devised for purely commercial ends, and the result is most emphatically satisfactory. This much is shown by the fact that at the St. Louis fur auction held on February 2, 1920, there were sold for the United States Government 9100 skins of fur seals which averaged 140.98 dollars per skin. Skins of the same quality in 1918 averaged no more than 46.34 dollars, but in 1919 the price had risen to 78.38 dollars. Thus the cost of this fur has risen by leaps and bounds, and it is anticipated that it will rise yet higher. "In the future," Dr. Hornaday remarks, "when all other bearers of good fur have been utterly exterminated—*as they soon will be*—the protected fur seal herds will produce . . . a really vast quantity of the finest fur in the world. It needs no stretch of prophecy to foretell the annual increment to the three nations (the United States, England, and Japan) who are now so sensibly preserving the fur seals of Alaska from killing at sea."

THE Forestry Commission has made considerable and satisfactory progress both in the acquisition of land and in planting. Landowners have shown considerable sympathy with the objects of the Commission, and in several cases free gifts of land or long leases on specially favourable terms have been obtained. The area of land acquired in the United Kingdom is as follows:—England, 9177 acres; Wales, 6329; Scotland, 23,472; and Ireland, 4716. This excludes lands acquired by the Department of Agriculture for Ireland, administered by the Commission. In addition, without taking into account estates which are merely under consideration, negotiations are proceeding in respect of the following areas:—England, 24,973 acres; Wales, 7900; Scotland, 6956; and Ireland, 7000. During the season 1919–20 the area of land planted, most of which is showing satisfactory progress, was 850 acres in England, 535 in Scotland, and 200 in Ireland. To meet the heavy cost of transport and the shortage of plants, new nurseries are being set up in the more important planting areas. Every effort is being made to increase the supply of seed and of seedlings. In conjunction with the

Ministry of Labour, the Commission has established at Brockenhurst, New Forest, a school for the forestry training of disabled ex-Service men, to be opened this month. A similar school is open at Birnam, near Dunkeld, and a new school for forest apprentices has recently started at Beauly, Inverness-shire. Offers of land may be addressed to the offices of the Assistant Commissioners at 22 Grosvenor Gardens, London; 25 Drumsheugh Gardens, Edinburgh; or 6 Hume Street, Dublin. All inquiries should be addressed to the headquarters of the Commission at 22 Grosvenor Gardens, London.

THE passages in classical literature which have been quoted in support of the assertion that mother-right existed in ancient Italy are discussed in the June issue of *Folk-lore* by Mr. H. J. Rose. One of the most daring attempts to support this position is a review of the succession of the members of the great Iulio-Claudian house (Journal of the Royal Anthropological Institute, vol. xlv., 1915, pp. 317 *sqq.*). A number of these counted their descent from women, but of matrilinear descent proper we have not a trace. In Italy, as Mr. Rose remarks, "we cannot, whatever we may do in Greece, weave sociological fantasies from the relationships of the gods, for the excellent reason that the Italian *numina* have no families. If any better arguments remain I shall await their production with interest, but, frankly, I have small expectation of anything of the sort."

IN a discourse delivered on March 12 last before the Royal Institution Mr. W. W. Rouse Ball, of Trinity College, Cambridge, gave an instructive illustrated account of the art of weaving string figures, usually made by weaving on the fingers a loop of string about 6½–7 ft. long so as to produce a pleasing design, often supposed to suggest a familiar object either at rest or in motion. Mr. Ball remarks that "friends who have learned the rules tell me that in convalescence and during long journeys the amusement has helped to while away many a tedious hour; moreover, the figures are easy to weave, they have a history, and they are capable of many varieties. Thus even in England the game may prove well worth the time spent in learning to play it; and admittedly to the very few who travel among aborigines it may sometimes be of real service."

MR. A. L. ARMSTRONG describes, in the *Naturalist* for July, with an illustration, an interesting series of six bone implements picked up by Mr. W. F. Jackson on a ploughed field at Rocher Head, Bradfield, near Sheffield, in 1888. They were associated with a number of well-worked implements of flint, consisting of round and horseshoe scrapers, a "spoon" scraper, and several trimmed flakes and knives. The collection has recently been examined by Mr. Reginald Smith, of the British Museum, and Sir W. Boyd Dawkins, who agree in regarding them as belonging to the Late Neolithic or Early Bronze age. The bones are those of an unidentified mammalian long bone, small metatarsal bones of a horse, and one of a bird. The largest specimen seems to have been rubbed down to form a blade on one long edge for about half its length, and it may have been used in dressing skins. They may be the grave furniture of a tumulus now demolished, or may represent a hoard.

DR. WM. MCDOUGALL deals, in *Mind* (N.S., No. 115, July, 1920), with the problem of motives in the light of recent discussion. He reviews briefly his own point of view as expressed in "Social Psychology," the view, namely, that the instincts are the mainsprings or motives of all man's activity. He then considers, first, the criticism and suggested alterations of Prof. Woodworth, who in "Dynamic Psychology" maintains that, in addition to the instincts, other mechanisms, *e.g.* native capacities and acquired habits, have also driving force; and, secondly, those of Mr. Graham Wallas, who seeks to establish thought as an independent native capacity containing its own "drive." Dr. McDougall considers the various arguments brought forward by these critics, but fails to find them convincing, and himself brings further evidence in support of his original contention. The article is interesting and suggestive to all who, whether from the theoretical point of view of abstract thought or from that of the practical necessities of life, find themselves confronted with the difficult problems concerned with human motives.

IT is well known that the large European ground-beetle, *Calosoma sycophanta*, has been introduced into the eastern United States in order that it may prey upon caterpillars destructive to deciduous trees. Messrs. C. W. Collins and Clifford E. Hood have shown (*Journ. Agric. Research*, vol. xviii., No. 9, 1920) that an American tachinid fly, *Eubiomyia calosomae*, has formed the habit of laying eggs on the introduced beetle, within which the maggots feed.

WE have received No. 15 of the Journal of the East Africa and Uganda Natural History Society (November, 1919), which contains, among other interesting papers, a lecture on "The Geological History of the Rift Valley," delivered at Nairobi by Prof. J. W. Gregory, who narrates how on his journey of 1893 he had encamped on the unoccupied site of that now busy and important town. Dr. G. D. Hale Carpenter, in "Discursive Notes on the Fossorial Hymenoptera," summarises the results of his studies on the habits of tropical African Sphegidæ and Pompilidæ. This well-produced journal is, we notice, printed in England; so are the Annals of the Transvaal Museum, of which vol. vii., part 3 (June, 1920), comprises an important systematic entomological paper, "On the South African Notodontidæ," by Mr. A. J. T. Janse.

WHEN the surface of a lava-stream hardens, the lava below may continue to flow, forming a tube beneath the frozen crust. In some volcanic areas lava-tubes of small size are abundant, but those of great length are rare. In the Monthly Bulletin of the Hawaian Volcanic Observatory for March, 1920, Mr. S. Power describes and illustrates a tube near Kilauea of unusual size, known as Thurston's tube, 1494 ft. in length, with a maximum height and width of 20 ft. and 22 ft. respectively. It opens into the Kaluaiki pit crater, and is one of the channels by which the crater was drained shortly before the final disappearance of the lava-lake.

In the last issue of the *Bollettino* of the Italian Seismological Society (vol. xxii., 1919, pp. 129–42) Dr. Agamennone describes a series of slight earthquakes at Frascati on November 6–7, 1909, of the same nature as true volcanic earthquakes, and yet originating on the flank of the extinct volcano of the Alban Hills. Small as is the area covered by these hills, Dr. Baratta distinguishes within it nine seismic zones, and the interest of the shocks described lies in the evidence which they offer of the continual migration of activity from one of these zones to another. The same number of the *Bollettino* contains Dr. G. Martinelli's catalogue of 568 earthquakes felt in Italy in 1917 (pp. 164–87). This takes the place of the very full pre-war reports which formerly occupied several hundred pages every year. While the completeness of the record does not seem to have suffered under war conditions, the catalogue in its restricted form has lost none of its usefulness for statistical purposes.

In the latest part of the Transactions of the Nova Scotian Institute of Science (vol. xiv., part 4) Prof. John Cameron describes two remarkable human skulls from South Malekula, in the New Hebrides. They seem to have been elongated by distortion through bandaging in infancy, and they exhibit the enormous development of the frontal air sinuses which are such a marked feature of the Melanesian skull. These sinuses not only produce very prominent superciliary ridges, but also, with the large maxillary sinuses, cause a flattening of the upper and lower margins of the orbit, imparting to it a quadrangular shape. The various features are compared with those of the known fossil human skulls from Europe.

During the war the Geological Survey of Egypt had the opportunity of obtaining some of the interesting fossil vertebrates from the Lower Miocene estuarine deposits at Moghara, and it has just published a description of the collection in a "Contribution à l'Etude des Vertébrés Miocènes de l'Egypte," by M. R. Fourtau. The fish-remains, on which there are notes by M. F. Priem, are unimportant, but among the reptilian remains there are fine skulls of new species of Crocodilus and Tomistoma and of a new genus of gavials named Euthecodon. The primitive artiodactyl mammals of the family Anthracotheriidæ are represented as usual by many valuable fragments, and there are several teeth of Mastodon. Dinotherium is curiously absent, and M. Fourtau finds it difficult to explain why this genus should be found with Mastodon further south in Africa. One tooth of a hyæna is the sole fragment of a carnivore, but there are two portions of mandibles of anthropoid apes which are of great interest. The figures of these two fossils are very unsatisfactory, but according to the description one seems to represent a new genus related to Hylobates, while the other may belong to a species of Dryopithecus.

Two lecture-demonstrations to teachers of science in secondary schools on "The Study of Crystals in Schools," given by Mr. T. V. Barker at the University Museum, Oxford, on August 10–11, are published in a small pamphlet by the Holywell Press, Oxford. In the first lecture some of the salient facts of crystallography were experimentally demonstrated on growing crystals by means of the lantern-microscope, in order to illustrate the lecturer's view that some instruction about crystals should be given in all chemical lectures and laboratories. It was pointed out that almost every answer to an examination question on atomic-weight determinations will include a dissertation on Mitscherlich's discovery of isomorphism learnt from a text-book, yet probably neither the candidate nor even the writer of the text-book had ever seen isomorphous crystals, and still less proved them to be so by simple measurement. In the second lecture some simple crystal measurements were made of microscopic crystals on the screen and of larger crystals with a contact goniometer, and the properties of cleavage, hardness, and density were also demonstrated on a variety of crystallised substances. The object aimed at, of showing the possibility of introducing simple experiments on crystals into secondary-school natural science teaching as part of the physics and chemistry courses, and of demonstrating how interesting to young people such experiments could be made, appears to have been fully attained, and doubtless many of the teachers who attended will make some effort to respond in their own schools, and thus to give our possible future chemists an early idea of the great value of crystallography to the chemist.

A valuable contribution to South African botany is a paper on new and interesting South African mosses by Mr. H. N. Dixon (Trans. Roy. Soc. South Africa, vol. viii., part 3, 1920), in which the results are given of the work on collections received from various districts during recent years. A considerable number of novelties are described, new records established for South Africa, and many of the genera or species critically examined.

In the *Kew Bulletin* (No. 5, 1920) Dr. A. W. Hill gives some account of the Tresco Abbey Gardens, Scilly Isles, emphasising their claim to be regarded as an Imperial asset of great importance to the botanists of this country whose work concerns the botanical resources of the British Empire, and pointing out the desirability of arranging that systematic botanists should be given facilities for studying in the Gardens in the living condition the plants with which they have become familiar in the herbarium. In this favoured spot may be studied not only the principal features of the temperate regions of New Zealand and outlying islands, of Australia, and of South America, but also many of the characteristic features of the sub-tropical vegetation of South Africa. A great number of plants were introduced from Australia, New Zealand, and South Africa about the middle of last century by Mr. Augustus Smith, whose botanical enterprise and interest in gardening were continued by his nephew and heir, Thomas Algernon Dorrien-Smith, who succeeded to the lordship of the islands in 1872, and, since the death of Mr. Dorrien-Smith in 1918, by Major A. A. Dorrien-Smith. A feature of the collection is a large series of drawings of many of the interesting plants which have flowered in the Gardens. Dr. Hill refers to the possibility of growing New Zealand flax as a crop for the production of fibre in the Scilly Isles in co-operation with growers in Cornwall.

PROF. AUGUSTINE HENRY and Miss Margaret Flood contribute to the Proceedings of the Royal Irish Academy (vol. xxxv., B5, May, 1920) a botanical and sylvicultural account of the species of Douglas fir comprising the genus Pseudotsuga. The Douglas fir of North America is one of the great timber trees of the world, and includes two species, one the Pacific Coast, Oregon, or green Douglas fir (*Pseudotsuga Douglasii*), and the other the Rocky Mountains, Colorado, or blue Douglas fir (*P. glauca*). The Oregon species forms forests of immense trees on the Pacific Coast, and is now much cultivated in the British Isles, where its rapid growth and enormous yields of timber in a short term of years render it very valuable. The Colorado species throughout its home in the Rocky Mountains is much inferior in size and vigour, and is of little or no value in commercial afforestation in this country. The paper is mainly concerned with a comparative study of these two species, but is extended to include an account of the whole genus. In all, seven species have been distinguished; besides the two already mentioned, a third American species with very large cones occurs in Southern California, another in Japan, and there are also three very closely allied species, two native in Yunnan and one in Formosa. The microscopic structure of the leaves has been found to be a distinct and constant character in each species, evidently correlated with the special climate in which the tree is native. The oil obtained by distillation of the leaves of the Colorado and Oregon species respectively proves to be very distinct in chemical composition.

THE Meteorological Service of the Philippines has recently issued part iii. of the Report of the Weather Bureau for 1917. The report is entirely statistical, and contains the observations made at the secondary stations during the year. All the results are carefully collated and examined at the Central Observatory under the supervision of the director, the Rev. José Algué, S.J., and the tables fill 360 pages, closely printed. The stations extend from latitude 6°–20° N. and longitude 118°–144° E. Observations at first- and second-class stations are for each four hours, six daily, for most elements, and annual summaries are given for these stations at the end of the volume. Observations at third-class and rain stations are made twice daily. In all cases the results are separated into months, and the means and totals given. The stations in all number fifty-four. For world-meteorology, and especially for aviation, the Meteorological Service of the Philippines is doing work of a very high order. Data are given for atmospheric pressure, air temperature, relative humidity, rain, wind direction and movement, and cloud form and direction. A rough examination of the wind directions and the movement of the clouds is of considerable interest. The movement of wind is greater, and calms are far less numerous, during the day than at night. Easterly and north-easterly winds prevail generally during the winter, and southerly and westerly winds during the summer. There is a distinct range of wind in the twenty-four hours. Upper and lower cloud observations are given twice daily; the direction of upper clouds is less regularly entered than that of lower, and the latter show commonly a veering of four points or more in comparison with the surface wind at the corresponding time.

ONE of the Meteorological Office publications, a section of the *Geophysical Journal*, gives daily values of certain elements at the Meteorological Office observatories. The data, which are not all observed every day, include air pressure, temperature and humidity, wind direction and velocity, sunshine and rain, cloud amount and weather, solar radiation and grass minimum, magnetic elements, earth temperature, atmospheric electricity, earthquakes and aurora, nephoscope observations, and pilot-balloon soundings. The normals are not of equal value, as we find at Kew Observatory 45, 35, 30, and 12 years for different elements, and at St. Louis (Jersey) 26, 25, 23, 22, and 16 years; while of the four wind observatories three give the daily maximum gust, while the fourth can give only the velocity during the windiest hour. There are other points of considerable dissimilarity between the different observatories. Eskdalemuir is, of course, of recent foundation, but it does not seem necessary to quote five-year normals in the ninth year, and it would be better to adopt fresh normals every year until at least the tenth in the case of a new observatory. The South Kensington normals are for a seven-year period, so that the quinquennium is obviously not insisted upon. The information about the height of the anemometer head above the cups at Holyhead appears to be conflicting, figures of 4·2 m., 6·1 m., and 4·0 m. being all derivable from the headings.

THE benefits accruing from a considered system of engineering standardisation have met with but a tardy recognition in Australia. It was not until the necessities of war pressed the subject to the foreground that any tangible steps were taken towards introducing a systematic scheme for engineering standardisation in the Commonwealth. The Institute of Science and Industry has given considerable attention to the matter, and after informing itself fully as to what has been done in other countries, and consulting various experts in Australia, it has put forward the outline of a scheme for the creation of an Australian Engineering Standards Association. This scheme has now been agreed to by the engineering societies, and a recommendation made to the Commonwealth Government for the establishment of a Standards Association. In the meantime, the Institute of Science and Industry has taken a further step and issued an Australian Standard Specification for Structural Steel, with appendices as to the forms of standard tensile test-pieces and data as to standard sections, sizes, weights, and sectional areas.

Our Astronomical Column.

LIVERPOOL UNIVERSITY TIDAL INSTITUTE.—The first annual report of this institute, established in 1919 with funds provided by Sir Alfred and Mr. Charles Booth, gives a brief and interesting account of the work so far taken up under the auspices of Prof. J. Proudman, the honorary director, and Dr. A. T. Doodson, the secretary. Besides theoretical work on the seiches in Lake Geneva and on the dynamical equations of the tides, the study of tide-prediction has been vigorously prosecuted. The official British and American predictions of the tides in the Mersey, calculated by machines of Lord Kelvin's type on the basis of analyses made many years ago by a committee of the British Association, often differ by a foot in height between themselves, and from the actual observed heights by amounts up to 3 ft. Dr. Doodson finds that the predicting machines are susceptible to error, though further examination is necessary to determine whether to an extent which unfits them for use in research. Meanwhile, the institute has embarked on an intensive study of the tides at Newlyn, near Land's End, from the continuous record taken by the Ordnance Survey. This work has also been assisted financially and otherwise by a British Association committee. Analysis has been made by computations on a novel plan; the five most important constituents in the tides were first removed, using approximate values inferred from the results of analyses for neighbouring stations. This reduced the range from 18·5 ft. to 2·5 ft., and disclosed the presence of quarter-diurnal constituents, which also were removed by a method suggested by theoretical considerations. This revealed constituents of higher orders and the presence of some unremoved semi-diurnal constituents, as was to be anticipated. By this method the real constituents are discovered, and these alone removed.

LONGITUDE BY AEROPLANE.—The *Comptes rendus* of the Paris Academy of Sciences for August 2 contains a paper by M. Paul Ditisheim describing a new determination of the Paris-Greenwich longitude by the repeated transfer of a series of chronometer watches between the two observatories by an aeroplane. Twelve watches were used which had previously been tested at Teddington with most satisfactory results. They were packed in wooden cases surrounded by layers of wool, and remained in a horizontal position during transit. They were compared with the standard clocks at Greenwich and Paris by Mr. Bowyer and M. Lancelin respectively. The average time of transit was 2¾ hours; on one occasion the double journey was completed on the same day.

The resulting longitude difference is 9m. 20·947s., with a probable error of 0·027s. It is only 0·005s. less than the mean of the British and French results in the 1902 determination. It is needless to say that the new value does not claim anything like so much weight as that of 1902, in which the observers were exchanged and personal equation was eliminated. It is, however, an interesting confirmation of it, and it illustrates the fact, already known, that the use of the travelling wire in observing transits greatly diminishes personal differences. This fact gives ground for hope that the method of wireless signals, without interchange of observers, will give close approximations to the longitudes of all the participating observatories.

OBSERVATIONS WITH THE PHOTO-ELECTRIC CELL.—Prof. Joel Stebbins's valuable pioneer work with the selenium cell (with which he discovered the secondary minimum of Algol) is now being continued with still greater refinement with the photo-electric cell. The *Astrophysical Journal* for May contains two of his researches. The first is on the Algol-variable λ Tauri. The light-curve much resembles that of Algol, a secondary minimum being shown here also. Elements are deduced from Prof. Stebbins's results combined with the spectroscopic ones. The masses of the two stars are 2·5 and 1·0 times that of the sun; the radii are 4·8 and 3·6 times the sun's; and a third body is suspected with mass 0·4. The side of the secondary that is turned towards the primary is much brighter than the other, which is ascribed to the intense radiation of the primary.

The other star examined is π^5 Orionis. The variability was detected before Prof. Stebbins noted that it had already been classified by Lee as a spectroscopic binary (with only one visible spectrum). The total range of light is only 0·06 magnitude, yet the observations suffice to give a consistent curve. As this proves to be a sine-curve with two periods in the time of revolution, it is concluded that the light-variation does not arise from eclipse, but from the spheroidal figure of the bright component. The ratio of axes is 0·95, which is quite a reasonable figure.

Prof. Stebbins states that he has at last succeeded in obtaining a potassium cell, with walls of fused quartz, that gives complete satisfaction. It was only after ninety-eight trials that this result was reached.

The Scientific Investigation of the Ocean.

NEED FOR A NEW "CHALLENGER" EXPEDITION.

THE outstanding feature of the proceedings of Section D (Zoology) at the meeting of the British Association at Cardiff was the discussion on August 26 on the need for the scientific investigation of the ocean.

In opening the discussion, Prof. W. A. Herdman, president of the Association, pointed out that this need may be considered under two heads—the scientific need and the industrial. Simply as a matter of advancing knowledge, the need for much further investigation of the ocean is very great indeed, and biologists realise that the industries connected with those marine animals—fishes and others—which are of economic importance are all of them badly in need of scientific investigation. There is not a single marine animal in regard to which it can be said that we know anything like all there is to be known and fully understand its mode of life. Even our commonest fishes, such as the herring and the cod, are in some respects unknown and mysterious to us. Prof. Herdman then proceeded to give a few examples of the need for further investigation.

The first report of the Tidal Institute of the University of Liverpool, issued a few weeks ago, shows that the two independent published predictions of the Liverpool tides—one issued by the Admiralty and the other by the United States Coast and Geodetic Survey—"seldom agree; they often differ by a foot in height; also, both of them sometimes differ from the actual tide by as much as 3 ft. in height." It is evident from this report that the present state of affairs urgently calls for more scientific research both in regard to the theory of the tides and to the accuracy of observations.

The work of the bio-chemist and of the physical chemist in connection with hydrography seems likely to be of fundamental importance, *e.g.* the possibility of determining the point of entrance to known currents of water by means of indicators showing the hydrogen-ion concentration may be of practical utility to navigators. Then again, Otto Pettersson's submarine waves in the Gullmar Fjord and elsewhere, and their possible influence on the winter herring fisheries, is a subject worthy of further investigation. Enough is known as to the influence of variations in the great oceanic currents upon the movements and abundance of migratory fishes to indicate the need for further and more complete investigation of the subject.

Prof. Herdman pointed out that, though we may suspect that the periodic changes in the physico-chemical characters of the sea may be correlated with the distribution at different seasons of the microscopic organisms that are an important source of food to larger animals, the matter has still to be proved and worked out in detail. The plankton curve has to be traced and the succession of organisms explained in terms of environmental conditions, including the ion-concentrations in the water and the amount and quality of solar radiation, and that not only in temperate seas, but also in the tropics and in all the oceans, and at various depths. It is known that many marine animals are profoundly affected in their distribution by the hydrographic conditions. For example, it has been shown that the herring of our summer fisheries is influenced in its movements by the temperature of the water, the catches being heavier in seasons when the water is colder, so long as it is not below 54·5° F., when the shoals break up and disperse.

Bionomics is the basis from which all oceanographic work on the biological side started, and there is still much to be done in tracing and explaining the life-histories and distribution and relations of marine plants and animals. In this connection, Prof. Herdman referred to the recent investigations of Dr. Joh. Schmidt, who has devoted the present summer to an oceanographic expedition in the Atlantic, the work of which included a search for the spawning eel.

The whole of the large question of the evaluation of the sea—a natural extension of the old-fashioned faunistic work—is a great field for research lying before the oceanographer of the future. Dr. Petersen in Denmark has done notable work in the Kattegat and the Limfjord, but it is probable that the "animal communities" which he has defined differ in other seas, and will have to be worked out independently in each marine area. Prof. Herdman cited the excellent marine surveys made by Sumner at Wood's Hole and by the Royal Irish Academy at Clare Island as work on the right lines as a preparation for the evaluation of large areas.

Similarly, systematic plankton work, studied intensively and treated statistically, and correlated with the food of migratory fishes and of the post-larval and other young stages of all food fishes, is a promising subject requiring much further investigation. Dr. Hjort's suggestion that the future year-classes of commercial fishes may depend not only upon favourable spawning seasons, but also upon an exact coincidence between the appearance of the phyto-plankton in sufficient quantity in spring and the time of hatching of the larval fishes, provides a subject of careful and difficult investigation and of far-reaching practical importance. A cognate subject bearing upon the same practical results—viz. future commercial fisheries—is Dr. Johnstone's demonstration of a natural periodicity in the abundance of certain fish. The extent and causes of this periodicity clearly call for further investigation; and in any discussion of, say, pre-war and post-war fishery statistics, the possibility of this periodicity affecting the question must be kept in mind.

Prof. Herdman emphasised the point that it is impossible to keep purely scientific research and investigations with a practical end in view completely separate. They are inter-related, and the one may become the other at any point. It was in the purely scientific investigation of the bionomics of the "warm" and "cold" areas of the Faroe Channel, in the *Triton* in 1882, that Tizard and Murray incidentally discovered the famous Dubh-Artach fishing-grounds which have been so extensively exploited since by British trawlers. It was a French man of science, Prof. Coste, who made the investigations and recommendations that started the flourishing oyster industries at Arcachon and in Brittany. It was his purely scientific studies of the deep-sea deposits that enabled Sir John Murray to discover the valuable phosphatic deposits of Christmas Island.

Metabolism, the cycle of changes taking place in the sea, the income and expenditure and the resulting balance available, is perhaps the department of oceanography which deals with the most fundamental problems and is most in need of immediate investigation.

The question of the abundance of tropical plankton as compared with that of temperate and polar seas, the distribution and action of denitrifying bacteria, the variations of the plankton in relation to environmental conditions, the determination of what constitutes uniformity of conditions over a large sea-area from the point of view of plankton distribution, the questions of the ultimate food of the ocean, the supply of the necessary minimal substances such as nitrogen, silica, and phosphorus to the living organisms, and the determination of the rate of production and rate of destruction of all organic substances in the sea—these are some of the fundamental problems of the metabolism of the ocean, and all of them require investigation. Most of these, moreover, are cases where the biologist or the oceanographer requires to appeal for assistance to the bio-chemist. In fact, in many oceanographic investigations team-work, in which the specialists of two or more sciences unite in tackling the problem, leads to the best results.

To the question, then: Is there need for further investigation of the ocean? Prof. Herdman answered emphatically in the affirmative, and referred, in conclusion, to the two suggestions made in his presidential address: (1) that there should be established at Cardiff a department of oceanographic and fisheries research, and (2) that there should be a great national oceanographical expedition—that is, another *Challenger* expedition, fitted out by the British Admiralty, and embracing all departments of the science of the sea investigated by modern methods under the best expert advice and control. Such an expedition would require long and careful preparation, so even though the present time may seem to some inopportune to press such an undertaking, if this suggestion is received with favour by oceanographers, it might be wise to form a preliminary committee to collect information and prepare a scheme.

Prof. J. Stanley Gardiner urged that to obtain results in economic work on fisheries there must be advance in wider scientific research. He endorsed the suggestion of the president for the establishment of oceanographical investigation in Cardiff, and said that, in his opinion, if this country is to keep in the forefront of oceanographical research, a new *Challenger* expedition has become necessary.

Dr. E. J. Allen supported the proposals for a new deep-sea expedition, and illustrated the need for further researches on marine organisms by reference to his recent experiments at Plymouth on the culture of plankton diatoms in artificial sea-water. He found that in solutions of pure chemicals, having as nearly as possible the composition of sea-water, to which nutrient salts such as nitrates and phosphates were added, diatom cultures did not develop, but when to such artificial sea-waters traces (say 1 per cent.) of natural sea-water were added, very good growth occurred. Experiments indicated that probably an organic substance in the natural sea-water stimulated growth, but its composition was still quite unknown. The culture method had also been used to obtain a minimum figure for the number of organisms living in a given volume of natural sea-water, and had shown that, whereas the number obtained in the usual way with the centrifuge was 14,000 per litre for a particular sample, there must actually have been at least 460,000 per litre.

Dr. E. C. Jee directed attention to the necessity for elucidating the movements of the current of dense water which pours out of the Mediterranean and forms an intermediate layer in the deeper waters of the near Atlantic Ocean. It seemed to him likely that the current moves northward, and in certain circumstances comes to the surface within the region of the pelagic fisheries of the British south-western area. It is important to ascertain the influence of this current on the northward migration of planktonic organisms and on the migrations of plankton-feeding fishes, and the investigation of its boundaries would throw light on the salinity variations observed in the surface waters of the English Channel, which are known to exhibit varying degrees of periodicity.

Mr. C. Tate Regan remarked that the study of the ocean was important in many other ways than in relation to fisheries, *e.g.* it was found, during the war, that a knowledge of salinity and currents was of great value in regard to submarine operations and the course of drifting mines. He suggested that work oversea should include the investigation of the seas on the coasts of our colonies; the fauna of the great area within the 100-fathom line that surrounds the Falkland Islands and extends northward to Montevideo is known only from two hauls made by the *Challenger* and five or six by the *Albatross*. In view of the pre-eminence of our Navy, mercantile marine, and fisheries, this country should lead the world in oceanographical research.

Prof. C. A. Kofoid pointed out that the magnitude of oceanographical problems and their diversity necessitate a definite but flexible programme and the co-operation of many investigators, for without such co-operation results must be fragmentary. Standardisation of methods, elimination of unnecessary duplication, and international co-operation are indispensable. He remarked upon the need for a monthly bulletin which should contain a bibliography of the subjects in this field of work together with synopses of the contents of these papers—a work which might well be undertaken by the International Commission for the Investigation of the Sea. He referred briefly to the project for the renewed exploration of the Pacific which is under consideration by a committee of the National Research Council of the United States.

Prof. J. E. Duerden urged that in the organisation of any extensive scheme of research in oceanography, or of a new *Challenger* expedition, the possibility of assistance from, and co-operation with, the various Dominions should be kept in mind. He had no doubt that, upon proper representation being made, the Union of South Africa would take its part, both financially and in *personnel*.

Mr. F. E. Smith, director of scientific research at the Admiralty, stated that his department had considered the question of a new *Challenger* expedition, and was of opinion that such an expedition was required, and he felt sure that the Admiralty would take its share in the organisation thereof.

At the close of the discussion a resolution was unanimously agreed to pointing out the importance of urging the initiation of a national expedition for the exploration of the ocean, and requesting that the council of the British Association should take the necessary steps to impress this need upon his Majesty's Government and the nation. On the following day, at the Committee of Recommendations, this resolution also received vigorous support from other sections, *e.g.* those dealing with chemistry, physics, geology, and geography, in all of which, as well as in zoology, investigations are required which could be undertaken by such an expedition. The General Committee of the Association recommended the Council to appoint an expert committee to prepare a programme of work and to consider the *personnel* and apparatus required. It is the hope of all those who have heard the cogent reasons for the expedition that it may be possible for the Government, in the not distant future, to undertake this great enterprise.

The New Star in Cygnus.

FROM the occasional observations which I have been able to make of the nova in Cygnus, I have formed the impression that the star has followed the normal course for such objects, except that the rise to maximum may have been more prolonged, and the subsequent decline in brightness more rapid, than usual. On August 22, two days after discovery, bright lines were not discernible with a small spectroscope attached to a 3-in. refractor, thus suggesting that the maximum had not then been reached. The star was seen for a short time on August 23, when it had risen to nearly second magnitude, but there was no opportunity of making spectroscopic observations. On August 26 observations were made by Sir Frank Dyson and myself with the 12-in. reflector of the Penylan Observatory, Cardiff, from 10h. to 11h. G.M.T. The star was then very slightly brighter than δ Cygni, but not so bright as γ Cygni, so that its magnitude would be about 2·8. Bright lines were then well developed, Hα being conspicuous, and also the group of four lines in the green assumed to be Hβ, 4924, 5018, and 5169. On August 28, so far as could be observed with a 3-in. telescope (in London), the spectrum showed no marked change, though the star had then fallen to nearly fourth magnitude.

A. FOWLER.

The announcement of the discovery of the new star in Cygnus was received at the Hill Observatory, Sidmouth, on the afternoon of August 21, but the cloudy state of the sky prevented any observation being made on that night. The sky was, however, clear on the night of August 22, and several photographs of its spectrum were secured. The following table sums up the observations taken since that date, and shows the fluctuations in magnitude recorded and the number of photographs of the spectra taken:—

Day.	State of Sky.	Estimated Magnitude.	No. of Spectra obtained.
21	Cloudy	—	—
22	Clear	2·8	4
23	Cloudy	—	—
24	Clear	2·2	3
25	Clear	2·2	5
26	Clear	2·8	4
27	Cloudy	—	—
28	Clear	3·6	3
29	Clear	3·8	4

On the night of August 22 the spectra were all very closely similar to that of α Cygni, the type of star which presents the most prominent enhanced-line stage. The nova spectra indicate dark hydrogen absorption lines only a little broader than those in α Cygni, and the dark enhanced lines are sharp and well defined, and correspond line for line with those in α Cygni. The only conspicuous bright lines are those at $H\gamma$ and at $H\beta$ and to the red side of $H\beta$. The nova had increased in magnitude by August 24, and all the lines in the spectrum became more diffuse and broader, the bright lines increasing in number towards the violet.

On August 25 the star was estimated to have retained the same magnitude as on August 24. All lines appeared a little more diffuse and the bright lines more conspicuous.

Dimming down to magnitude 2·8 on the night of August 26, the main spectral changes indicated an increase in intensity and width of the bright lines, so much so that the dark hydrogen lines became less broad, owing to the overlapping of the bright components. By August 28 the magnitude of the nova had reduced considerably, but the spectrum exhibited no great changes except that the bright hydrogen components showed signs of splitting up into two parts. On the night of August 29 the fall in magnitude had decreased somewhat, the star being about 3·8. The splitting up of the bright hydrogen components was more pronounced. All photographs exhibit extensive movement in the line of sight.

The foregoing general features illustrate only the most conspicuous changes in the spectrum up to date. The nova seems now to be following the ordinary course of the sequence of phenomena of previous new stars.

WILLIAM J. S. LOCKYER.

This object continued to brighten until the night of August 23, when it attained the second magnitude; since that date the decline of lustre has been considerable, and on August 29 I estimated the magnitude as 3·9.

It is probable that in a week's time the star's light will be reduced to the sixth magnitude, in which case it will only be just visible to the naked eye on a clear, dark night.

The astronomical world has been fortunate during the last twenty years in being able to study the phenomena of three bright temporary stars, viz. Anderson's Nova Persei of 1901, Nova Aquilæ of 1918, and the one now visible.

W. F. DENNING.

British Agriculture during Great War Periods.

A VERY interesting article by Lord Ernle appears in the June issue of the *Journal of the Ministry of Agriculture*. The subject is "Agriculture during Two Great Wars," and the state of agriculture in Great Britain during the Napoleonic wars is compared and contrasted with that prevailing during the recent struggle.

Shortage of corn was the great fear of our ancestors, and if the home harvests were deficient the deficiency had to be met by supplies from Northern Europe. But, since the climatic conditions of the two regions are practically the same, scarcity at home generally meant scarcity abroad. The weather was of the utmost importance, and everyone watched the skies with great anxiety. Provision for such a deficiency was, therefore, one of the main features of the Corn Laws down to 1815. If home harvests were abundant, then exports were encouraged by a bounty and imports of foreign corn were limited. Foreign corn, with its additional costs of freight and insurance, could rarely have lowered the price of English corn, while during scarcity home consumers benefited from the large corn acreage which was maintained by the export bounty. Between 1801 and 1816 the yearly average of foreign wheat imported was under 600,000 quarters, while in 1821 the imports were only 450,000 quarters. Yet between 1801 and 1821 the number of people supplied with home-grown breadstuffs had risen from 14,000,000 to 20,500,000.

Weather conditions were adverse for the greater part of the Napoleonic wars, yet food was not rationed, neither were prices controlled. The Government probably relied on the high prices to prevent extravagance in the use of a scanty supply. The condition of some of the poor people was improved by increases in wages and by the distribution of privately raised funds. To give relief the Poor Law was invoked, and this was a fatal blunder, the full consequences of which appeared only after the peace. Various other measures were adopted at different times: bread could not be sold until it was twenty-four hours old; the manufacture of spirits and starch was suspended; rice and maize were imported to mix with cornflour; the growth of potatoes was encouraged, and the corn bounties rose continually.

In spite of all this, the war period was a time of great prosperity for landowners and farmers. Enormous sums were spent on the erection of farm buildings, cottages, etc., and on the reclamation and improvement of land. A much higher standard of farming was adopted, and a better class of men was attracted to the land. After the war wages fell, unemployment was rife, and a period of great poverty followed. During the succeeding hundred years the economic importance of agriculture dropped from one-third to one-twentieth in terms of gross national assessment. The breadstuffs grown in 1821 would have supplied double the number of people provided for in 1914, and the agricultural interest, which was paramount in 1814, has now lost the greater part of its political power.

Naturally, these changes have been reflected in the agricultural policy adopted during the recent war. Although the agricultural industry has prospered, its prosperity has been small as compared with the period 1793–1815. The incentive of high gains, which provided the spur for great efforts during the French war, was not allowed to operate fully. During the latter part of the recent war much more was done for the consumers than for the producers, and the great exertions of the farmers in the face of unexampled difficulties were therefore all the more creditable. Fixing a flat maximum price for wheat meant that what was a good price in a good year would be a bad price in a bad year, and the whole loss fell on the farmer. In the French war the poorest consumers were subsidised out of the rates, while in the late war all consumers were subsidised out of the taxes. In all probability the farmer saved the taxpayers about 25,000,000*l.* between the years 1917 and 1919. The farmers experienced further difficulties in the shortage of labour, and to have secured an increased food-supply under these conditions was not only a notable achievement, but also a most valuable contribution to victory.

The labourer was the worst sufferer after the French war, but during the recent war and since the armistice agricultural wages have been increased and the hours of labour have been shortened. It is now universally recognised that the position of agricultural labourers must be improved. If high wages and shorter hours result in greater efficiency, then the industry will prosper; if they do not, then the industry will exist only under conditions which restrict employment. Lord Ernle concludes: "It rests with the men—and their leaders. Unless a new earth is created, there can be no new heaven to inherit."

Experimental Cell Studies.

In an experimental study of cell and nuclear division, especially in *Vicia faba*, Sakamura (Journ. Coll. Sci., Imp. Univ. Tokyo, vol. xxxix., article 11) has made an important contribution, particularly with regard to the factors that may influence the form, size, and number of the chromosomes. He finds, in agreement with most previous investigators, that *V. faba* has twelve chromosomes, the earlier counts of fourteen being due to a constriction which appears constantly at a certain point on the longest pair of chromosomes. Two other species of Vicia have fourteen chromosomes, three have twelve, while *V. unijuga* is tetraploid, having twenty-four.

The investigations of Nemec and others in chloralising root-tips and studying the effects on mitosis and the multiplication of chromosomes have been considerably extended, including treatment with benzene and chloroform vapour, ether, carbon dioxide, high temperature, electric currents, Röntgen rays, plasmolysis, and infection by the Nematode worm Heterodera. The chromosomes often shorten and thicken under this treatment, irregular mitoses occur, and frequently the number of chromosomes is multiplied, but there is no evidence of later reduction divisions in somatic tissues. Irregular reduction divisions in the pollen formation were also obtained by similar treatment.

A study of the chromosomes of wheat gives very different results from those of previous investigators. *Triticum monococcum* is found to have fourteen chromosomes (2×), four derivatives of Emmer wheat are found to have twenty-eight (4×), while three descendants of Dinkel wheat have forty-two (6×). This is a confirmation of the view that *T. monococcum* is the most primitive, while *T. vulgare* belongs to the most advanced, type—a view which is supported also by the phytopathological studies of Wawiloff, the serological tests of Zade, and the evidence from sterility of the various hybrids as obtained by Tschermak. The fundamental importance of cytological studies of agricultural plants is thus apparent.

R. R. G.

University and Educational Intelligence.

Cambridge.—Mr. H. H. Brindley, St. John's College, has been re-appointed demonstrator of biology to medical students; Mr. J. T. Saunders, Christ's College, demonstrator of animal morphology; and Mr. J. Gray, King's College, demonstrator of comparative anatomy. Mr. E. J. Maskell, Emmanuel College, has been appointed to the Frank Smart University studentship in botany.

Graduate research studentships at Emmanuel College have been awarded to E. J. Maskell for research in plant physiology, to C. H. Spiers for research in stereochemistry, and to G. L. Jones for research in Celtic and Frankish institutions.

Dr. Griffith Taylor, at present physiographer in the Commonwealth Weather Service, Melbourne, has been appointed to a specially created position of associate professor of geography in the University of Sydney. He will take up the duties of his new position in the early part of 1921.

A reunion of old students of the Royal College of Science, London, will be held on Tuesday, September 14, at 7 p.m., at the Imperial College Union, Prince Consort Road, South Kensington, London, S.W.7. The president, Sir Richard Gregory, will take the chair at 8 p.m., and Prof. H. E. Armstrong will deliver an address entitled "Pre-Kensington History of the Royal College of Science and the University Problem."

The issue of the *Lancet* for August 28 is a medical students' guide for the session 1920–21. The various curricula are described in detail, and under their respective headings the necessary information concerning the facilities for medical study offered at the different teaching centres of the United Kingdom is given. The regulations for the examinations, both preliminary and professional, at these centres are set out so that the student desiring to obtain a medical degree from a university or a diploma from any medical corporation may ascertain the course of clinical instruction and the conditions under which submission for examination is allowed. The metropolitan medical schools and hospitals are grouped under the University of London; similarly, all hospitals in direct connection with provincial universities are described under the appropriate university. Finally, an account is given of the conditions under which commissions can be obtained in the Navy, Army, Air Force, Indian, and Colonial Medical Services.

We have just received a "Handbook of Lectures and Classes for Teachers," issued by the London County Council. The range of subjects offered is very wide, and all the courses will be conducted by experts. Under the heading of geography, lectures will be given on physical geography, the use of instruments, and regional and historical geography—a course which will extend over two years. In addition, there will be lectures on the past and the future of the great towns of the world, and one lecture on regional surveys. In the department of mathematics the teaching of arithmetic, of mensuration and geometry in junior schools, and of elementary mathematics will be dealt with in five courses of lectures during the year. Science will be represented by courses of lectures on modern theories of time, space and matter, psycho-analysis, psychology, elementary astronomy, the special senses, experimental investigation of children, the industries of the Stone age, insects in relation to agriculture and disease, and laboratory arts, and there will be one lecture on insects as disease-carriers. As usual, there will be a course of single lectures on special subjects: Prof. J. N. Collie will lecture on the rare gases in the atmosphere; Prof. A. Fowler on recent developments in astronomy; Prof. A. Keith on the antiquity of man; Prof. R. Biffen on agricultural botany; Dr. Bateson on the heredity of sex; Dr. Forster on chemical technology; and Sir W. H. Bragg on the romance of science. The lectures will be open to all teachers employed either within or outside the administrative county of London. Full directions for the application for tickets of admission will be found in the handbook.

Societies and Academies.

Paris.

Academy of Sciences, August 9.—M. Henri Deslandres in the chair.—A. **Blondel**: A new optical or electrical apparatus for the measurement of oscillations of velocity and angular deviations. The method is based on the registration on a photographic film moving at a uniform rate of the angular displacements of a disc carrying a series of equidistant slits, the disc being attached to the axis of the machine under examination. An application of the method to the study of an internal-combustion engine is given.—M. **Petot**: Extract from a letter to M. Appell concerning the spherical representation of surfaces.—B. **Delaunay**: The number of representations of a number by a binary cubic form with negative discriminant.—F. **Carlson**: The zeroes of the series of Dirichlet.—C. **Frémont**: Cause of the frequency of breakages of rails at their extremities.—J. **Rey**: Perrot's experiment relating to the movement of rotation of the earth. In 1859 Perrot observed certain rotations in a jet of water flowing from a hole in the base of a cylindrical vessel, and regarded these as due to the rotation of the earth. Laroque, in 1860, concluded that the observed phenomena were not connected with the earth's rotation, but many phenomena in geophysics have since then been explained on the assumption of the validity of Perrot's views. Experiments are described which lead to the conclusion that Perrot's views are erroneous, and fully confirm Laroque's criticisms.—H. **Godard**: Observations of the periodic comet Tempel II. made at the Bordeaux Observatory with the 38-cm. equatorial. The apparent positions of the comet and comparison stars for July 24, 25, and 27 are given.—A. **Buhl**: The symmetries of the electromagnetic and gravific field.—E. **Darmois**: The influence of ammonium molybdate on the rotary power of malic acid. A crystallised compound of malic acid and ammonium molybdate has been isolated. Its rotatory power is very high (+219°), and constant over a wide range of concentrations. There is a probability that this is not the only complex compound formed when ammonium molybdate is added to solutions of malic acid.—A. **Portevin**: The similitudes of micrographic aspect existing in various states between the iron-carbon (steels), copper-tin (tin bronzes), copper-zinc (brasses), and copper-aluminium alloys (aluminium-bronzes).—J. **Bougault** and P. **Robin**: Catalytic oxidation by unsaturated bodies (oils, hydrocarbons, etc.). Dichloroethyl sulphide, which alone or in solution is unaffected by oxygen, in presence of turpentine readily oxidises on exposure to air, the sulphoxide $SO(CH_2.CH_2Cl)_2$ being formed. By a similar oxidation, thiodiglycol in presence of citral is readily oxidised by air to the sulphoxide $SO(CH_2.CH_2.OH)_2$.—R. **Souèges**: The embryogeny of the Compositæ. The last stages of the development of the embryo in *Senecio vulgaris*.—P. **Lesage**: Experiments utilisable in plant physiology on osmosis and on the aspiration due to evaporation.—M. and Mme. G. **Villedieu**: The action of rain on the deposits of copper mixtures on plants.—J. **Amar**: How to determine the output of workmen.—A. **Migot**: The formation of the axial skeleton in *Eunicella (Gorgonia) Cavolinii*.—MM. **Fauré-Fremiet**, J. **Dragoiu**, and Mlle. Du **Vivier de Streel**: The histochemical differentiation of the fœtal pulmonary epithelium in the sheep.—M. **Piettre** and A. **Vila**: Some properties of serine.—C. **Leballly**: The virulence of the milk in apthous fever. The milk is virulent before any appearance of symptoms characteristic of the disease, the high temperature being the only indication of departure from the normal healthy condition.—E. **Alilaire** and E. **Fernbach**: Some observations on the culture of the tubercle bacillus in non-glycerinated media.

ROME.

Reale Accademia dei Lincei, April 11.—A. Ròiti, vice-president, in the chair.—U. **Cisotti**: Integration of characteristic equation of waves in a canal of any depth, iii. Formulæ for the effect of local perturbations are found.—P. **Comucci**: So-called hydrocastorite of Elba. Analysis shows that this is not a definite species of mineral, but rather a product of alteration found as a rule in different minerals of uncertain composition.—G. **Valle**: Interrupted incoherent sounds. An examination of the acoustical effects produced by sirens in which the openings are arranged in groups, the interval between which is not an exact multiple of the interval between the members of a group.—M. **Tenani**: Diurnal oscillations of wind velocity at different heights. Between May and September, 1917, regular observations were made with *ballons-sondes* at different times of the day at the Royal Aerological Station of Vigna di Valle for the purposes of aviation. The mean amplitude of diurnal oscillation decreases upwards, starting with 3 m./sec. at the ground. The oscillations parallel to the shore-line are almost negligible compared with those in a perpendicular direction. An attempt is made to determine a coefficient of correlation between the difference of temperature of earth and sea and the wind velocity perpendicular to the shore, but the mean error is too large to allow of the results being practically applicable up to the present.—C. **Ravenna** and G. **Bosinelli**: The dipeptid of aspartic acid and the function of asparagin in plants. In these experiments the dipeptid was obtained directly in a state of purity by prolonged boiling of a solution of asparagin.—R. **Raineri**: Corallinaceæ of the Tripoli coast, i. A description (accompanied by three figures) of the five species of the genus Lithothamnium found along the floor of the Tripoli Sea, namely, *L. crispatum*, *Haucki*, *Lenormandi*, *Philippii* (encrusting), and *fruticulosum* (lightly branching). Seven other species, to be described later, were also found.—M. **Ascoli** and A. **Fagiuoli**: Sub-epidermic pharmacodynamic experiences, iv. This deals with the action of thyroids and indirect effects.—L. **de Marchi**: Obituary notice of Prof. Vincenzo Reina, with list of works.—The Academy passed a resolution expressing the hope that the Government would secure for the nation the "Villa Gioiello," near Arcetri, in which Galileo spent the last ten years of his life.

April 25.—F. D'Ovidio, president, in the chair.—L. **Tonelli**: Points in the calculus of variations.—E. **Clerici**: A pulverulent mineral from Dorgali, in Sardinia. This mineral produces luminescence when heated. By comparing the corresponding effects with various fluorites it is inferred that this phenomenon arises from the presence of traces of rare earths.—R. **Raineri**: Corallinaceæ from Tripoli, ii. The remaining species are *Lithophyllum expansum*, *lichenoides*, *byssoides*, and *decussatum*, and *Melobesia Lejolisii*. In addition, two corallines with articulate thallus occurred.—L. **Pigorini**: Colouring matters from the eggs of silkworms. One gram of eggs was treated with a mixture of alcohol and acetone and the coloured extract tested with a Duboscq colorimeter. The coefficients of extinction of the various colours were found to differ according to whether the eggs were laid by the white, golden, or yellow type of female, or, again, by crosses of the two latter, and the results were sufficiently marked to be practically useful in testing the variety to which the ova belong.—L. **Pigorini** and R. **Grandiori**: Action of sulphide of lime on Lepidopterous ova. Pigorini found that sulphide of lime dissolves the shell of the egg without damaging the living elements, and Grandiori uses the method in his embryological studies of the eggs of *Bombyx mori*, *B. Yamamai*, and *Orgiya antiqua* with great success.—R. **Grandiori**: Symbiotic micro-organisms in *Pieris brassicae* and *Apanteles glomeratus*. Observations were made on four embryonic stages of the Pieris, in which were found symbiotic forms similar to others previously seen to penetrate the hypoderm of the parasitic Ichneumon.

CAPE TOWN.

Royal Society of South Africa, July 21.—Dr. A. Ogg, vice-president, in the chair.—P. A. **van der Bijl**: The genus Tulostoma, Persoon, in South Africa. This is a widely distributed genus, and in South Africa two species are thus far known, viz. *Tulostoma cyclophorum* and *T. Lesliei*, a new species, which the author describes in this paper.—P. A. **van der Bijl**: A fungus, *Ovulariopsis papayae*, n.sp., which causes powdery mildew on the leaves of the pawpaw plant (*Carica papaya*, Linn.). The author describes a fungus found in Natal on the under-surface of the pawpaw leaves as a new species, for which the name *Ovulariopsis papayae* is suggested.—P. A. **van der Bijl**: South African Xylarias occurring around Durban, Natal. Four species of Xylarias have thus far been collected by the writer around Durban, and of these three have not been previously recorded from South Africa.—W. A. **Jolly**: Note on the spinal reactions of the Platana. The author gives a note of reflex times observed in the spinal preparation of the Platana of the Cape Peninsula (*Xenopus laevis* or an allied species).—J. R. **Sutton**: A possible lunar influence upon the velocity of the wind at Kimberley (third paper). This paper deals with the variations in the speed of the wind when the moon is furthest from the earth. The discussion follows the same lines as the previous one, which dealt with the speed variations at perigee. The results obtained go to confirm the earlier ones. The diagram curves show generally the same turning-points as the perigee curves, but later in time, and the moonrise minimum is not so pronounced. The apogee curves average lower on the scale than the perigee curves. While the velocity of the wind tends to rise at perigee when the moon is above the horizon, it tends to fall at apogee.

SYDNEY.

Royal Society of New South Wales, July 7.—Mr. T. H. Houghton, vice-president, in the chair.—Dr. S. **Smith**: *Aphrophyllum Hallense*, gen. et sp. nov., and Lithostrotion from the neighbourhood of Bingara, N.S.W. The corals are referred by the author to *Lithostrotion arundineum* and *L. Stanvellense*.—J. H. **Maiden**: Descriptions of three new species of Eucalyptus. The first is a dwarf, mallee-like stringybark, from between Port Jackson and Broken Bay, closely allied to a moderately large tree, *Eucalyptus capitellata*. The second species comes from the summit of Mount Jounama, at an altitude of about 5400 ft., thirty miles south of Tumut. It is a large tree, a gum, and the bark falls off in strips as much as 30 ft. long. It is allied to the snow gum, *Eucalyptus coriacea*. and to one of the mountain ashes, *E. gigantea*. The third species comes from the drier parts of Western Australia, and it may be spoken of as the dry country representative of the Yate, *E. occidentalis*.

Books Received.

The Land of the Hills and the Glens: Wild Life in Iona and the Inner Hebrides. By S. Gordon. Pp. xii+223. (London: Cassell and Co., Ltd.) 15*s*. net.

Die Binokularen Instrumente. By Prof. M. von Rohr. Zweite Auflage. Pp. xvii+303. (Berlin J. Springer.) 40 marks.

A Text-book of Electrical Engineering. Translated from the German of Dr. A. Thomälen by Dr. G. W. O. Howe. Fifth edition. (London: E. Arnold.) 28*s*. net.

Einführung (Handbuch der biologischen Arbeitsmethoden). By E. Abderhalden. Pp. 44. (Berlin und Wien: Urban und Schwarzenberg.) 4 marks.

The Advancement of Science, 1920: Addresses delivered at the Eighty-eighth Annual Meeting of the British Association for the Advancement of Science, Cardiff, August, 1920. (London: John Murray.) 6*s*. net.

The Andes of Southern Peru: Geographical Reconnaissance along the Seventy-third Meridian. By I. Bowman. Pp. xi+336. (New York: The Geological Society of New York; London: Constable and Co., Ltd.) 27*s*. 6*d*. net.

Water-Plants: A Study of Aquatic Angiosperms. By Dr. Agnes Arber. Pp. xvi+436. (Cambridge: At the University Press.) 31*s*. 6*d*. net.

A First Course in Nomography. By Dr. S. Brodetsky. Pp. xii+135. (London: G. Bell and Sons, Ltd.) 10*s*. net.

Etude sur le Système Solaire. By Dr. P. Reynaud. Pp. xiv+83. (Paris: Gauthier-Villars et Cie.)

The Sea-Shore. By W. P. Pycraft. Pp. vi+156. (London: S.P.C.K.) 4*s*. 6*d*. net.

A First German Course for Science Students. By Profs. H. G. Fiedler and F. E. Sandbach. Pp. x+99. (London: Oxford University Press.) 4*s*. 6*d*. net.

CONTENTS.

THURSDAY, SEPTEMBER 9, 1920.

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Science and Labour.

A FORTNIGHT ago the British Association was in session at Cardiff, and men of science were engaged in making and discussing contributions to the world's store of natural knowledge. This week the Trades Union Congress meets at Portsmouth, and representatives of manual labour are asserting their industrial and political claims with no uncertain voice. The spirits of the two bodies are as the poles apart. On one side we have the explorer, animated solely by zeal for discovery and eager to learn of new fields in which pioneers are prospecting: on the other we have workers seeking—no doubt reasonably in some cases—full rights and privileges for particular occupational interests, and aiming to use these interests for political power.

It is not within the province of NATURE to discuss these ambitions of manual labour, or to anticipate the effects of a policy which, to say the least, has little constructive work behind it. We may, however, deal appropriately with the relations of science to labour, especially as the activities of both are essential to human progress and prosperity. Schemes for securing greater pay for less labour occupy most of the attention of the public Press and social platform, while the vastly more important subject of the creation of wealth through scientific discovery and industrial application is almost unheeded by the very people who profit most by it.

Labour alone may build pyramids to-day, as it did four thousand years ago, but it cannot create new industries without new knowledge, and this is obtained by scientific research, whether carried on in an academic laboratory or in the works. Without the aid of science and invention, this country would be in the condition of China, where four-fifths of the population are peasant cultivators of the soil, and the social condition of the people is far below that of any British working class. The fullest encouragement must, of course, be given to the greatest of our industries—agriculture—but it should also be remembered that there are only about as many acres of permanent pasture and arable land together, in the United Kingdom, as there are people in this kingdom, and that we must depend largely for our existence upon foreign trade. By the use of our knowledge and the development of our natural resources we have to be able to offer other countries what they are not yet in a position to produce for themselves, for the lack of either one or the other of these factors of prosperity. Resources can be exhausted, but scientific discovery can continually provide new openings for industry, and the nation which makes the best use of it can be assured of a leading position for its products in the markets of the world.

When, about the end of the eighteenth century, the home demand for corn exceeded the home supply, the population of England and Wales was about nine millions: now it is about forty millions, and we have to look to improved methods of cultivation, and to the production of new varieties of wheat, to enable us to provide more than a week-end supply of food. As a large and progressively increasing proportion of the world's inhabitants feed upon wheat, markets from which we now obtain supplies will also have the demands of other countries to meet, and it will be necessary for us to grow more of our own, as well as to produce goods which other countries will purchase from us.

We now export textile goods to the value of nearly three hundred million pounds annually, and we are able to do so, not because of any specific aptitude on the part of the British manual worker, but because of machinery and of chemical industry, which produces the dyes required for piece goods. Fifty years ago nearly all the cotton grown in the United States was exported to Europe: now, every year more and more raw cotton is being used in the mills of the New England States, and we have to seek fresh sources of supply for our raw material. India is also developing its cotton industry to supply its own needs, and the tendency must always be in this direction when a country concerns itself with progressive industry. China has not yet reached this condition, and therefore it exports raw cotton, wool, and silk, and imports textiles made from them. We are able to send into China cottons and woollens to the value of about ten million pounds annually, solely because we are in advance of that country in science and invention.

We have reached our position as a great industrial nation by the use of scientific knowledge, and we cannot go back to the time when domestic manufactures and home markets were our only concern. China is rich in the very natural products to which our country largely owes its prosperity, and through which a large part of the population secures profitable employment. There is enough coal in the province of Shansi alone to last the world for several thousand years, yet China has not benefited from its riches because of its indifference to progressive knowledge. Two hundred years ago we were in much the same condition. At that time the total quantity of coal raised in Great Britain was not more than a few thousand tons, whereas now the annual output approaches three million tons. Our early coal mines were not more than about 180 ft. deep, and it was the invention of Newcomen's pumping engine that enabled the depth to be extended to about 300 ft. Now, thanks to Watt's steam-engine, and modern methods of ventilation and coal-getting, shafts can be sunk and coal seams worked at ten times this depth. Our buried treasure would have remained hidden in the bowels of the earth to this day, and the million or so miners who derive their living from them would be without an occupation which owes its growth entirely to the steam-engine and other machinery which science and ingenuity have provided.

These workers now number about 5 per cent. of the occupied persons in this country, and they threaten to hold up most of the nation's industries unless certain demands they make are granted. Whether their peremptory action can be justified or not we will not attempt to discuss, but we do ask them to remember that they owe their occupational existence to science, and that men of science really hold the key of power to all industrial positions. A few hundred chemists engaged in dye manufacture, or a few thousand in the production of sulphuric acid, could paralyse almost every industry if they adopted the action by which the coal-miners now challenge the Government of this country.

The closing of the coal mines would mean the stoppage of our iron and steel trade, upon which our industrial greatness has been built, and here again the industry owes its modern development to such men of science as Sir Henry Bessemer, Dr. William Siemens, and Sir Robert Hadfield, to mention three only. Iron ore occurs in China almost as widely diffused as coal, but it is a talent buried in the ground, and the country derives little profit from it, either in employment or in power. The Chinese possess to a supreme degree the conservative spirit which opposes all advance or change, and we should have remained in their position if vested interests, either of employer or of employed, had been permitted to control national development, and industry had failed to take advantage of scientific discovery. Manganese and nickel, titanium, molybdenum, tungsten, vanadium, and other elements now used in steel-making were all products of scientific investigation, and from them wealth has been created and work provided.

It would be easy to show that science has been the source of development of our chief industries and that a single scientific discovery, like that of magneto-electricity by Faraday, for example, contributes far more to human progress than the action of all the politicians and labour leaders put together. The discovery of thorium and cerium made possible the manufacture of incandescent gas mantles, of which about four hundred millions are now produced annually, and from osmium and tungsten have developed the great production of metallic filament lamps. Aluminium, discovered in 1827, has risen from the position of a rare metal to a yearly tonnage exceeded only by iron, lead, copper, zinc, and tin, and it is manufactured exclusively by electrolytic methods, which would never have come into existence but for the investigation by men of science of the chemical effects of the electric current.

The workers are now strong enough to exact their fair share of the profits arising out of the applications of science, and no one wishes to dispute their just claims in this respect. In their deliberations, however, they should occasionally show that they realise the part which science plays in opening up new fields of work without itself sharing in the distribution of the wealth it creates. Probably, if there were a complete levelling of all incomes, wage-earners would not benefit by more than about 5 per cent., yet this is the subject upon which attention is mostly concentrated, while the means of increasing the amount of wealth to divide by creating new industries or increasing the output of individual workers are given little consideration. It should be obvious that the greater the value of industrial production through science and labour, the more will be the profits to be shared, and that the curtailment of productive capacity must mean eventual disaster. The Labour Party has stated that it "has the duty of placing the advancement of science in the forefront of its political programme." We look to it to justify this claim by presenting to the workers in true proportion the relative values of participation in profits and the creation of wealth through science, as determining factors of social improvement and industrial progress.

Development of Higher Education in India.

THE fact that applications are now being invited for seven professorships and five readerships in the University of Dacca will perhaps direct increased attention to the latest development of higher education in India. It is certainly most desirable that the scientific world at home should take an interest in the subject, and do everything possible to help in a movement that is unquestionably of Imperial consequence. For this new university is intended to mark an important departure; it is to be of the residential and teaching type, and both in its government and in its ways is to embody, so it is hoped, what is best in our universities, old and new, at home. The standard of admission of students is to be what is customarily the intermediate examination.

All who have first-hand knowledge of Indian universities, and many of those who have only indirect knowledge, will know how urgent is the need for reform. The situation easily admits of scathing criticism, but it will be more profitable to assist to the extent of our opportunities in this new constructive effort. No more need be said here of the past than that we have in India exactly what we might expect from the attempt to implant in the East, under Government auspices, a system of universities modelled on the London University of early Victorian days. We know at home to what degree our statesmen have been gifted with educational insight and how far their training has qualified them to adjust educational policy to the needs of a new age or of a different race. Those who wish to read in detail the story of Indian university development will do well to refer to the report of the Calcutta Commission, which was noticed at length in these columns on its publication last year (vol. civ., p. 357).

Dacca, as the ephemeral capital of Eastern Bengal, is well provided with all the material elements for making the university a success, and the Bengal Muslims declare themselves intent upon educational advance. If at the outset an academic staff can be assembled that will hold firm to the professed aims of the new university, it may succeed in conferring an incalculable boon upon India. The terms of the appointments will, it is to be hoped, prove sufficiently good to attract men of the necessary quality. A professorship at its best begins at about 1200*l*., rising by annual increments of 60*l*. to 2160*l*., and in addition there may be an allowance of 600*l*. a year. The normal age of retirement is to be fifty-five, when the benefits of a provident fund will accrue.

At the present time there will no doubt be more than the usual difficulty in recruiting first-rate university teachers for India. The abnormal demands of the home universities and the unsettled state of the world come into reckoning, in addition to the usual considerations of exile and climate. On the other hand, there is ground for expecting that in future those who take up educational service in India will not be penalised to the extent they have been in regard to promotion to appointments at home. It is to be hoped that the appointments at Dacca will be seen to afford a very special opportunity of national service and a true educational mission, and that they will appeal not so much to the spirit of adventure as to a real ardour for the advancement of learning by high and creative scholarship. The realisation of the aims of the new university, and the establishment of a compelling example that will lead others to mend their ways, will make a demand on the strength of character and fidelity to principle of its first professors not less than on their intellectual competence. There is surely much here to attract the best type of both character and talent.

As already announced, the first Vice-Chancellor of the new university is Mr. P. J. Hartog, lately Academic Registrar of the University of London. Distinguished in early days as a lecturer in chemistry at Manchester, and most recently by his leading part in the establishment of the School of Oriental Studies in London, Mr. Hartog will approach his task with ample breadth of intellectual sympathy. As a member of the Calcutta University Commission he gained direct knowledge of

Indian university conditions, and co-operated in designing the new institution of which he is to be the chief academic officer. His abundant experience, gained amid the conflicts of London University, will be invaluable for his new duties, for it is the transformation of examining into teaching universities that constitutes the central problem in India. If the difficulties have been great at home, they are still greater there. Nothing seems so urgent, among all the ills that afflict Indian education, than that the strangling grip of university examinations should be released from the throat of learning.

It is true that under the strong and persuasive influence of the Calcutta Commission the aspiration for university reform has received a large measure of native assent, and this is no doubt quite sincere. But the currents of an evil tradition are strong and deep; rights and privileges of very serious social import have become established; a suspicion is apt to arise that attempts at reform are attempts to restrict and deprive, and that they are actuated by a desire to check, rather than to aid, the advance of that kind of learning which will best help the Indian to progress and self-dependence. This hovering distrust will assuredly attend the early labours of Mr. Hartog and his colleagues, but even if they cannot move far towards realising "a fresh synthesis of Eastern and Western studies," which is the stated ideal of their university, they may, with good fortune, inaugurate a salutary and far-reaching reform.

The Foundations of Aircraft Design.

Applied Aerodynamics. By G. P. Thomson. Pp. xx+292. (London: Hodder and Stoughton, Ltd., n.d.) Price 42*s.* net.

MR. THOMSON has made no mention of his own share in the work which he describes, but it is common knowledge that the development of experimental methods, more particularly in full-scale research, owed much to his initiative during the war. At one period, as a member of the experimental staff of the Royal Aircraft Establishment, he took an active part in the now historic debate on "scale effect": at a later date he joined the staff of the Aircraft Manufacturing Company, and there obtained first-hand acquaintance with the routine of a commercial design office. Such varied experience, combined with a considerable amount of actual flying, constitutes the best possible qualification for authorship of a text-book on the practical applications of aerodynamic theory, and the present volume, as we should have expected, abounds in happy illustrations of the interaction of constructional and aerodynamic considerations in design; but it does not of itself tend to ensure clear and systematic presentation of results, and we believe that by devoting a longer period to deliberation and planning Mr. Thomson could have produced a better book.

Let us confess at once that we have found it quite exceptionally difficult to form our judgment of this volume, and that we may have had a wrong idea of the class of readers for which it is primarily intended. Mr. Thomson's preface is not very explicit on this point, but taken in conjunction with Col. O'Gorman's introduction it certainly seems to suggest that he has catered principally for the designer, whilst keeping in view the needs of R.A.F. officers training; in other words, that his book is intended both as a work of reference and as a manual of instruction. But if so, then form and arrangement, we cannot but think, become matters of very real importance, and it is on this score that we venture the foregoing criticism. At our first reading of the text, the difficulties which confront the student impressed us so much as almost to obscure its very real merits; and although on a second examination we were able, with our acquired knowledge of the whole book, to appreciate and enjoy the author's success in compressing so much valuable material into some 280 pages of large type, we cannot help thinking that our first impression was more representative of the view which an uninitiated reader would obtain. We suspect that Mr. Thomson, when he wrote, was too close to the work which he describes to be able to see his subject from the point of view of his readers.

The student, for example, who comes new to the subject ought always to be given the definitions of special terms and the meanings of special symbols used *before* he meets them in the course of the argument: he ought not to find casual references to "interference" scattered throughout chap. iii., and yet be denied a definition, even by implication, of this term until he reaches the very end of the chapter; nor ought he in chap. x. to find himself suddenly confronted by symbols to the meaning of which he is given no clue, save a general reference to two chapters in the second part of the book. In our experience, much of the difficulty of aeronautical literature consists in the sheer number of the symbols which it is found necessary to employ, and we would gladly exchange the glossary of aeronautical terms, which forms an appendix to this volume, for a tabulated list of symbols and their meanings—more especially now, when an excellent scheme for standardising these has been evolved by the Royal Aeronautical Society. The designer who will use the book as a work of reference doubtless has a better initial acquaintance with its notation, but since he will require to read the book piecemeal we suspect that his difficulties will be very much the same. For him it is most important that each several argument shall be as far as possible self-contained, with assumptions clearly stated at the outset. Now in some sections of the chapters on stability we can almost feel Mr. Thomson developing his thought as he proceeds: the discussion of a problem is begun with insufficient data; the scarcity becomes apparent as the analysis proceeds; assumptions have to be made, and are made, sometimes with little justification other than that of necessity. The sequence is typical of engineering as distinct from purely scientific investigations, since "engineering" (we believe the modification of Samuel Butler's epigram is due to Prof. Unwin) "is the art of drawing sufficient conclusions from insufficient premises": but it is not a suitable arrangement when the results of these investigations come to be "written up" for the practical man, who is apt to become bewildered by the steady accretion of assumptions, and even to be doubtful, at the finish, whether any new result has been obtained at all.

One feature of this book will, we believe, be of the very greatest service to its readers: there are practically complete references to original sources of information, even in instances where the reports quoted had not passed from the typewritten to the final form at the time of writing. (Incidentally, their authors' names are somewhat frequently misspelt.) The advantages of this information will be apparent to every serious reader, and of immense service to the designer. The book's own index is not equally successful; at all events, we have not found it of much assistance in compensating for the faults of arrangement which we have noticed above, and of which other instances might be given—such as the inclusion of actual experimental data, and of a carefully reasoned plea for further experiments on body-resistance, in a chapter ostensibly dealing with experimental methods, of a paragraph and three diagrams bearing on the distribution of forces between the upper and lower planes of a biplane under the chapter heading of "centres of pressure and wing-moments," and of Fig. 94, an illustration of experimental apparatus, in a chapter which otherwise is devoted to the discussion and application of experimental data.

We have failed in our intention if the foregoing criticisms suggest that we consider this an unsound or a carelessly written book; on the contrary, we are convinced that readers who have had some first-hand acquaintance with the work of which it treats will read it with real pleasure —and, after all, no better proof of its excellence could be adduced. Our only reason for thus emphasising the importance of arrangement and presentation is that we hope soon to see a second and revised edition in which these aspects have received greater attention: very little labour, we believe, would be required to make this work as satisfactory, regarded as a text-book of design, as it already is in essentials, whereas the impression which it will make upon the ordinary reader as it stands is not likely to do justice to its very real merits.

Food Poisoning.

Food Poisoning and Food Infections. By Dr. William G. Savage. (Cambridge Public Health Series.) Pp. ix+247. (Cambridge: At the University Press, 1920.) Price 15*s*. net.

THE subject of this work is one not only of great importance in medicine, but also of much scientific interest. It necessarily covers a very wide field, for the production of disease by food may depend upon any one of a large number of different conditions. A food may be inherently poisonous, or its ill-effects may depend upon some abnormal sensitiveness on the part of the consumer; it may acquire poisonous properties as the result of putrefactive or other chemical changes on keeping; it may become the vehicle of metallic poisoning from contact with containing vessels, or of bacterial infection resulting from animal disease, or from subsequent contamination with pathogenic organisms. Dr. Savage has rendered a great service, alike to medicine, to public health, and to pure science, in gathering together in a small volume the most recent and authoritative information upon the various ways in which health may be prejudicially affected by food. There is no one who could more fittingly have undertaken the task, for the subject is one of which he has a wide practical experience, and which he has made peculiarly his own. So well has he done the work that scarcely any unfavourable comment suggests itself, and a review must take the form, most pleasant to the reviewer, of a short account of the way in which Dr. Savage has treated his subject.

The first chapter is occupied by a short historical review, and the author then passes on to animal infections transmissible to man, a subject which, apart from the group of diseases due to Gärtner's bacillus and its allies, is dealt with briefly as not falling within the proper scope of the book. In discussing food as a passive vehicle of infection, Dr. Savage gives a very useful summary of experimental work on the temperatures reached in ordinary cooking. Many readers will be surprised to learn how inadequate ordinary boiling and baking are to destroy bacteria in the deeper parts of a large joint of meat, and how little reliance can be placed on cooking as a safeguard against infection. Foods inherently poisonous are the subject of the next chapter: poisonous fish scarcely occur in this country, but an adequate account is given of the effects produced by certain fungi, and of ergotism and lathyrism. Food idiosyncrasy is then discussed: the writer accepts the view, now usually held, that this is a question of anaphylaxis. Certain persons may be so abnormally sensitive to a particular foreign protein as to react against it, with symptoms recalling those of anaphylactic shock, even when it is taken by the mouth—a view which presupposes that some minimal amount escapes digestion and reaches the blood unchanged. The commonest protein against which such hypersensitiveness is exhibited appears to be white of egg, but even milk may be thus poisonous to certain individuals.

The largest section of the book is naturally devoted by the author to those outbreaks of acute gastro-enteritis so commonly described in the newspapers as "ptomaine poisoning," but which are now well known to be instances of infection with some member of the Salmonella group of bacilli. Here Dr. Savage is on his own ground; his report to the Local Government Board on this subject in 1913 is well known. The symptoms, mode of causation, pathology, and bacteriology are fully discussed, and a table is given of 112 outbreaks in this country, with the chief known data concerning each. (It is a pity, by the way, that Dr. Savage persistently uses "data" as a singular instead of as a plural word.) The bacteriology of the Salmonella group is an extremely interesting, but a very difficult, subject. We do not know whether the different food-poisoning bacteria are mere races of one type, or deserve the rank of separate species; it is a most puzzling thing that a single organism should be the cause of paratyphoid fever as a rule, and yet at times produce a gastro-enteritis which is clinically a quite different disease. Into this thorny question Dr. Savage scarcely enters, though he gives an excellent account of the known facts as regards both human and animal infections, together with a full and useful bibliography of the "Gärtner group." It is unfortunate that in many outbreaks of food-poisoning the bacteriological examination has been so insufficient that no certain facts can be gleaned, but the full instructions given in these pages should enable any bacteriologist to carry out an investigation on adequate lines.

Other forms of bacterial food-poisoning receive full discussion, but the weight of evidence seems against their importance, if not against their existence. Botulism, of course, is a well-known condition on the Continent and in America, and receives a chapter to itself. Special types of food-poisoning, such as those due to mussels, cheese, and potatoes, are also dealt with in a separate chapter, and seem to be chemical in their origin.

In a discussion on putrefaction an excellent popular account is given of the chemical and bacteriological aspects of that process, and Dr. Savage has no difficulty in laying the bogey of ptomaine poisoning. This hypothesis dates from a time before the rise of modern bacteriology; ptomaines are unquestionably formed during putrefaction, but their toxicity has been exaggerated, and they are present in any quantity only "when the food is far too nasty to eat."

Chemical poisons in food, unintentionally introduced, are dealt with under two headings—that in which they are introduced in processes of manufacture, and that in which they arise from the chemical action of the food upon the tins or other vessels in which it is put up; a further group is formed by the preservatives used to prevent secondary bacterial action. These subjects are treated in adequate detail, and in conclusion there is a chapter on the prevention of food-poisoning. The book is compact, well printed, and adequately indexed, and should be of signal service to the medical profession and to all engaged in public health work, while it is a mine of information to the bacteriologist, and so clearly written as to be of no small interest to the general reader.

Malaria at Home and Abroad.

Malaria at Home and Abroad. By Lt.-Col. S. P. James. Pp. xi+234. (London: John Bale, Sons, and Danielsson, Ltd., 1920.) Price 25*s.* net.

COL. JAMES'S book appears at an opportune time, when malaria, owing to the Great War and the return of soldiers from highly malarious countries, has acquired a much wider distribution than before. How wide that distribution is at the present time is seen on the map of the world in the frontispiece, and how it affected England in 1919 is shown on map 59, p. 90. It appears that since March 1, 1919, when notification of malaria became compulsory in this country, no fewer than 14,000 demobilised soldiers were, up to November, 1919, notified as suffering from relapses. These figures alone show the importance of the subject at home, while it is no less so abroad, for it is well known that malaria has become even more prevalent abroad than it was when Sir Ronald Ross made his epoch-making discovery as to the *rôle* of the mosquito in the spread of the disease, and wrote his classical work on its prevention.

Col. James has had a large experience of malaria in its endemic and epidemic forms, and he evidently possesses the gift of being able to impart his knowledge in an interesting way.

Lucidity and the maintenance of interest are essential in a book of this kind, for otherwise the many facts and details set forth in connection with the causation, spread, clinical features, pathology, diagnosis, treatment, and prevention of the disease would appeal only to a few specialists, whereas we hope this book will be read by every medical man and by our administrators in tropical countries. The volume is divided into ten chapters. The first is devoted to the life-history of the parasite and to the mode of spread of the disease; the second to the factors concerned in the spread of malaria. The next two chapters deal with the practical work necessary for inquiry into malaria, followed by chapters on a malarial survey in England and the tropics, and epidemiological observations in each. The remaining four chapters give an account of the symptoms, pathology, diagnosis, treatment, and prevention and eradication of malaria.

The illustrations number 104. They are a feature of the book, and very helpful to the reader, leaving less to the imagination than many other monographs. For instance, the photographs depicting the rot-holes in trees; roof gutters with blind ends where water lodges; cut bamboos and a common water plant are likely to give a truer and more lasting impression regarding the nature of certain breeding places of larvæ than any long description.

When giving an account of the clinical onset, course, and termination in ordinary cases of malaria, Col. James very properly points out that the primary illness does not always commence with very characteristic symptoms and signs, and he remarks that an atypical onset has been observed so frequently in primary cases of malaria contracted during the war that it is advisable to keep in mind the possibility of malaria as regards almost every illness in which, after proper clinical examination, some doubt as to the diagnosis remains. This requires to be borne in mind in view of the frequency with which soldiers who have served in the war have not suffered from their first attack of malaria until after their return home. This warning is repeated when describing the pernicious symptoms which may appear in infections with the malignant tertian parasite, and more rarely with either of the other two species of parasites. In such cases there may be in a patient who is obviously very ill an almost complete absence of what are known to be the usual clinical signs of malaria, and unless the blood is examined the malarial attack may be mistaken for sunstroke, alcoholism, acute heart failure, dysentery, cholera, appendicitis, etc. It is because of the protean character of this disease that Sir Patrick Manson, to whom this valuable book is dedicated, states in the preface that "no man has a right to practise in malarial countries or as a consultant in this country who cannot use his microscope in the diagnosis of malaria and other blood parasites."

The Oil Industry.

Animal and Vegetable Oils, Fats, and Waxes: Their Manufacture, Refining, and Analysis, including the Manufacture of Candles, Margarine, and Butter. A Practical Treatise. By Dr. Geoffrey Martin. (Manuals of Chemical Technology, ix.) Pp. x+218. (London: Crosby Lockwood and Son, 1920.) Price 12*s*. 6*d*. net.

SINCE the death of Dr. Lewkowitsch there have appeared quite a number of books on the oil industry, mainly based on his work. The present volume shows the advances made, inasmuch as more attention is devoted to recent industrial developments. Dr. Martin has produced a very valuable compilation of recent patents and improvements, which is well worth the perusal of anyone interested in the oil industry. Excellent chapters on the extraction (including that from waste products), refining, and hydrogenation of oils and fats, and on the candle industry, are given with profuse illustrations. Perhaps too much stress is laid on the volatile solvent process for the extraction of seed oils. Up to a few years ago oils extracted by this process were rarely to be found on the market, due no doubt to the difficulty found in the filtration of the extracted oils.

Coming to the general and analytical sections of the work, we do not find these entirely up to date. The portions dealing with linseed oil (oxidised and polymerised) and with the action of driers take no note of the recent work of Morrell, Ingle (J.S.C.I., 1911 and 1913), and Mackey (J.S.C.I., 1916 and 1917). Under linoleum the author states that linseed oil can be blown in five or six hours, whereas to obtain a suitable product, in our experience, eighteen to twenty hours are necessary. Also in the manufacture of linoleum cements he mentions an amount of kauri gum which is far in excess of that required. His assumption that in the blowing process (Wood and Bedford, and Walton) "superoxidised oil" is formed has not as yet been proved (see Ingle and Woodmansey, J.S.C.I., 1919, p. 101). Otherwise the brief description of the linoleum industry is good.

In discussing the oils used in the cloth trade, while the preparation of distilled oleines, etc., is well treated, the testing of them with regard to their application is too brief. We do not find any reference to the Mackey oil tester, and little mention of the danger of spontaneous ignition or other fire risks.

The analytical chapter is all too brief, though for the most part well done. The present writer has shown (J.S.C.I., 1902, p. 587) that Hubl's solution should be used fresh, and not after twenty-four hours' mixing, as Dr. Martin, copying Dr. Lewkowitsch, states. With regard to the preparation of Wijs's solution, Dr. Martin includes the method from iodine trichloride, a product of doubtful purity, and in this he follows the recommendation of the Government Committee of Analysts (Ministry of Food), but he also gives in the chapter the more trustworthy method by the saturation of glacial acetic acid solution of iodine with dry chlorine. Also one misses the details of the valuable hexabromide test.

With regard to the edible qualities of hydrogenated oils as compared with natural fats, such as butter and lard, it may be pointed out that the assumption of a continuous carbon chain in all the fatty acids has not yet been proved. It is probable that some of the unsaturated oils contain "branched chains" (Verzeigte Ketten), and so in hydrogenation isomeric stearic acids may be formed, and these may have quite different digestibility. Hence it does not follow that a stearine produced by hydrogenation would have the same food value as a natural fat.

The author reprints reports of the Government Committee of Analysts (Oils and Fats Branch, Ministry of Food) which we consider so inadequate that it is surprising that Dr. Martin gives them space.

On the whole, the work should prove of great assistance to the student of the industrial developments of the oil trade, but to the chemically minded it does not go far enough into the discussion of the application of scientific principles and tests to the industry. HARRY INGLE.

Science in History.

Transactions of the Royal Historical Society. Fourth Series. Vol. xi. Pp. v+247. (London: Royal Historical Society, 1919.)

TO scientific readers the most important communication in this volume is that by Sir Richard Gregory, entitled "Science in the History of Civilisation." There are, the author tells us, two methods of approaching the history of science—that of the specialist, who regards it purely as growth of the knowledge of material objects and phenomena in the course of time; and that of the historian of human culture, who dwells on its influence upon social and economic conditions. The object of this paper is to plead for a closer co-ordination of these separate points of view in works of general history. This has been attempted to some extent by Voltaire, Buckle, and Lecky, and in more recent times by Mr. and Mrs. Whetham and by Mr. F. S. Marvin; but some modern speculations have served only to darken knowledge. The late Mr. B. Kidd traced the cause of the evolution of society to the continuous action of religious beliefs, but Dr. Russel Wallace pointed out that the doctrine of progressive ethical impulse does not explain how the rude struggles of 2000 years ending in the sixteenth century could have tended to increase and develop the altruistic and ethical sentiments of early races in their struggle for existence.

The true age of science dates from the era of experimental investigation, advocated by Roger Bacon and advanced by Galileo and the men of his age. It is the scientific scepticism thus created which is responsible for the growth of knowledge and its effects to which all material advance is to be attributed. The question for the future is how to use rightly the power which science gives to modern man; not to teach it as a jumble of isolated facts and theories, but in the history of its development from the earliest times. The necessity of paying increased attention to the history of science has been urged by Sir J. J. Thomson's committee on the position of natural science in the educational system of Great Britain; and on the research side a group of students working with Dr. C. Singer at Oxford has produced the first volume of "Studies in the History and Method of Science," while a second is in the press, to be the basis, it is hoped, of a comprehensive "History of Science," on lines similar to those of the "Cambridge Modern History." This new movement is ably advocated in the paper under notice. C.

Our Bookshelf.

A Critical Revision of the Genus Eucalyptus. By J. H. Maiden. Vol. ii., parts 8–10. Vol. iii., parts 1–8. Vol. iv., parts 1, 3, 5–10. (Parts xviii.–xxviii., xxxi., xxxiii., xxxv.–xl. of the complete work.) (Sydney: W. A. Gullick, 1913–20.) Price 2*s*. 6*d*. per part.

AUSTRALIA, with an approximate area of 3,000,000 square miles, exhibits many peculiarities in its flora, one of which is the presence of large genera distributed practically throughout its full extent. Noteworthy among these are Eucalyptus and Acacia. Eucalyptus comprises species presenting the largest trees of the country down to dwarf bushes. Mr. Maiden's critical revision of the genus Eucalyptus, of which the first part was published in 1903, is now, we believe, approaching completion with the fortieth part. Nearly twenty years is a long time to wait for the termination of a work so greatly needed, yet the author may well be excused, considering his multifarious duties as director of the Botanic Gardens and Government domains; but it is a case of "better late than never." In spite of the pressure of other matter, the author and Government printers succeeded in publishing fourteen parts during the actual war period.

For the purposes of this monograph Mr. Maiden visited Europe to compare his materials with the type-specimens of the species published by earlier European botanists. In fact, he spared himself no trouble to reduce the complicated synonymy of certain species. How far he has succeeded can be discovered only by the student of his great work.

Mr. Maiden defines and figures upwards of 200 species. His illustrations are not artistic pictures, but they are something better, as they represent the specific characters, and are excellently drawn. For example, the leaves of many species of Eucalyptus present a great variety in form in the same species and even in the same individual. The seed vessels, too, differ considerably in shape in different individuals of the same species. These peculiarities are faithfully reproduced, and the origin of each figure is carefully indicated.

Following the descriptions is a more or less lengthy list of specimens belonging to the species in question. Full synonymy, with references to the place of publication, is given, and we understand that the author will deal with the classification of the species, of hybridity, and of other questions concerning the genus in a later part.

W. BOTTING HEMSLEY.

Annual Reports of the Society of Chemical Industry on the Progress of Applied Chemistry. Vol. iv. 1919. Pp. 632. (London: Society of Chemical Industry, 1920.) Price 12*s*. 6*d*. (non-members).

THE first three volumes of the annual reports on the progress of applied chemistry, issued by the Society of Chemical Industry, suffered from the stress of war conditions under which they were produced, and were inevitably incomplete in some respects. In the volume for 1919, the fourth of the series, the publication committee has, however, achieved its purpose of preparing a complete conspectus of progress in the various branches of applied chemistry. Moreover, some of the gaps which occurred in previous volumes have now been filled up. The subject of explosives is dealt with for the first time, the extremely interesting and valuable report covering the period from the beginning of the war until the end of 1919. The reports on ceramics, building materials, and fermentation for 1918, which had to be held over, appear together with the reports for 1919, and a section dealing with analysis, which was omitted from previous volumes, is also included.

The volume includes reports on progress during 1919 in practically all branches of chemical industry. The reports, although of necessity condensed, are generally both comprehensive and complete, and the authors are to be congratulated on the success with which they have accomplished their laborious tasks. The volume will undoubtedly be of the utmost value to technologists, and may fitly find a place on the library shelf beside the annual report of the Chemical Society, to which it is complementary.

Cotton Spinning. By William Scott Taggart. Vol. iii. Fifth edition. Pp. xxviii + 490. (London: Macmillan and Co., Ltd., 1920.) Price 10*s*. net.

THIS well-known and authoritative work on cotton spinning is published in three volumes. It deals with all the processes up to carding; with all appliances up to the end of the fly frame; and, finally, with the theory and processes of spinning and with mill planning, including the important subject of humidity. It has reached, in vol. i., a sixth edition, and in vols. ii. and iii. a fifth, which facts sufficiently mark the popularity and authority of the treatise. Vol. iii. has just been re-issued with important additions. The three volumes include no fewer than 543 detailed drawings descriptive of the sources and characteristics of the cotton fibre and of its treatment by means of the machinery through which it passes until it emerges as marketable yarn. They thus form a complete compendium of the several stages of manufacture of this important textile.

Vol. iii. deals especially with the treatment of the fibre necessary to ensure uniformity in the yarn and regularity of diameter and of length, weight, and strength so vitally essential to the production of a round, solid thread. Useful tables of information are given relative to the indicated horse-power required for the various machines, etc. Much new matter is to be found in Appendix ii., relating to gassing, costing, etc., and a detailed index adds considerably to the value of the volume.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Relativity.

THE relativist position is stated as being "that only relative motions are of physical importance."

If this is meant to apply to rotation as well as to motions of translation, and to deny that rotation is absolute, and independent of the relation of the revolving body to anything outside itself, I would suggest that a relativist should try the following experiment. Let two casks, A and B, of suitable sizes, be placed one within the other (A inside), and so mounted that either can be rotated independently. Now let the believer in relativity place himself inside A so that he can see nothing but its inner surface. So far as appearances are concerned, he will not know whether A is stationary or in motion.

First let A be stationary and let B be made to revolve at, say, 1000 revs. per minute. This will cause no change of any sort in the sensations of the occupant. Next, with B stationary, let A be given the same angular velocity for a minute or two. If the experimenter survives this trial, he will be in a position to assert that the "physical importance" of the angular velocity of A with reference to B is not the same as that of B with reference to A. So far, however, as the geometrical relations of A and B are concerned, it is a matter of indifference which of the two is revolving.

A. MALLOCK.

9 Baring Crescent, Exeter.

Toads and Red-hot Charcoal.

TOADS are associated with some wonderful myths, and my scepticism was naturally great when my friend Mr. H. Martin Leake assured me, while on a visit to Cawnpore in October of 1915, that toads would eat red-hot charcoal. An after-dinner demonstration, however, soon dispelled my doubts. Small fragments of charcoal heated to a glowing red were thrown on the cement floor in front of several of the small toads (usually *Bufo stomaticus*) which so commonly invade bungalows at that time of year, and, to my surprise, the glowing fragments were eagerly snapped up and swallowed. The toads appeared to suffer no inconvenience, since not only did they not exhibit any signs of discomfort, but, on the contrary, several toads swallowed two or even three fragments in succession. A probable explanation of the picking-up is that the toads mistook the luminous pieces of charcoal for glow-worms or fireflies, the latter being numerous in the grounds of the Agricultural College at Cawnpore in October; but this does not account for the swallowing of the hot particles—the absence of any attempt to disgorge. I repeated the experiment at Allahabad in August, 1916, with the same results (the toads even attempting to pick up glowing cigarette-ends), though I have never observed glow-worms or fireflies in Allahabad at any time of year.

The fact that some toads seized several hot particles in succession would seem to imply either that the heat was not felt (which seems incredible), or that memory is entirely absent in toads; but since toads most certainly come to associate a given time of day with the supply of food, *i.e.* remember, this latter explanation seems to be equally incredible. The truth must be that the incentive to seize an object (a luminous point in this instance) usually associated with an insect is so strong that even acute pain is no deterrent when the experience is limited—the lessons of experience out of the ordinary require to be "burned" into the toad intelligence by sheer repetition, just as the imprisoned shark which repeatedly bruises its snout against the glass of its tank has the lesson "knocked" into it in time. I may add that I unfortunately neglected to examine the toads post-mortem, and that I have recently repeated these experiments with *Bufo vulgaris* in England with entirely negative results.

W. N. F. WOODLAND.

"Kismet," Lock Mead, Maidenhead.

Active Hydrogen.

IN March last I observed an interesting phenomenon while conducting certain experiments, in the Maharajah's College, Vizianagaram, with detonating mixtures with excess of hydrogen when they are subjected to the silent electric discharge in an ozoniser. In one experiment the oxy-hydrogen mixture, after leaving the ozoniser, was allowed to pass through an alkaline solution of potassium permanganate. In the course of the experiment an electric spark accidentally took place in the mixture, and as a consequence an explosion occurred in which a part of my apparatus was smashed to pieces; but to my surprise I found that the whole of my permanganate solution turned green at once.

It was surmised from this that the instantaneous reduction might be due to the presence of an active modification of hydrogen produced in the circumstances, since molecular hydrogen brings about the same change very slowly. In order to study the problem more conveniently, I filled a Hofmann eudiometer with an alkaline solution of potassium permanganate, and a few cubic centimetres of an explosive mixture with excess of hydrogen (3 vols. of hydrogen and 1 vol. of oxygen) were admitted into the explosion tube and the mixture was sparked; as soon as the spark passed through the solution it turned green.

With the object of testing further the reducing efficiency of this new form of activated hydrogen, its effect was examined in a number of reactions. It was thus found that with this hydrogen an alkaline solution of indigo was converted into indigo white, ferric chloride into ferrous chloride, potassium nitrate into potassium nitrite, arsenious acid into arsine, potassium perchlorate into potassium chloride, and a number of other reactions were also tried with like results.

Some references to the literature relating to this subject of active hydrogen may be of interest. In 1913 Sir J. J. Thomson was led to conclude from examination of the paths of positively charged particles that they "revealed the presence of particles having an atomic weight of 3, presumably triatomic molecules of hydrogen." Duane and Wendt showed, in 1917, that when hydrogen is exposed to the bombardment of α-particles from radium emanation a contraction in volume occurs, a fact which has been incidentally observed by Usher, and confirmed recently by Lind. In 1912 Dr. Langmuir discovered an active modification of hydrogen by heating a metallic filament in hydrogen at low pressures. Again, so late as May last, Gerald and Robert S. Landauer published a paper on triatomic hydrogen in the Journal of the American Chemical Society.

These investigators activated hydrogen in different ways, all the methods being dependent on gaseous ionisation. The hydrogen was activated by the α-rays, by the electrical discharge in a vacuum, by the corona, and by Schumann light, though the last means of activating hydrogen was unsuccessful.

Sir J. J. Thomson found in 1913 (Proc. Roy. Soc., A, lxxxix., 20) that "X_3 disappears when a mixture of it with hydrogen is sparked with sufficient oxygen to give a violent explosion." In my experiments, however, I find that the active hydrogen appears with the explosion; moreover, the fact that under similar conditions with excess of oxygen ozone is produced, and with excess of hydrogen an active form of it makes its appearance, is significant when we consider the nature of the chemical process of the formation of water when explosive mixtures are subjected to an electric spark.

Y. VENKATARAMAIAH.
Indian Institute of Science, Bangalore, India,
July 23.

The Organisation of University Education.

THE discussion that has been started by the Government's offer of the Bloomsbury site to the University of London has already opened up a bigger question, namely, that of the vital necessity for re-organising thoroughly the university system—or quasi-system—of this country. It is becoming clear that we must have a regional university system, such that every area of sufficient population shall be provided with a fully equipped and fully staffed university as its educational centre and capital; and more and more it is becoming evident that the duties and services of each university will not by any means be exhausted by the teaching and research carried on therein, but that it must undertake besides the tremendously important work of organising tutorial education for the adult workers hungering after knowledge and the work of aiding and leavening and guiding all the secondary schools in its area. If we take account (1) of these considerations and all that they involve in the way of extra-mural organisation and supervision and teaching, (2) of the demand that the Imperial College of Science shall be elevated to university rank, (3) of the objection raised to the Bloomsbury site that ten times its acreage would be required for a university, and (4) of the recent plea that universities should be decentralised and located in the open so far as possible rather than in a city; it seems to follow that very probably the existing University of London will have to be divided into, or replaced by, some half a dozen or so independent universities, one or two central—as, *e.g.*, in Gower Street, etc., and Kensington—and the others in the outer ring to serve the large populations of the Kent and Surrey and Essex and Middlesex areas; and, if this necessity be made clear, no sentimental attachment to the old University of London ought to weigh against the unquestioned needs of education. Of course, millions would be required from the Government to carry out such a scheme; but perhaps one day we may have a Government that, instead of wasting many tens of millions on wild-cat military expeditions, will invest one or two tens in universities—to the incalculable gain of the country.

It seems to me, however, that, if the universities themselves admit the need for regional division and systematic organisation, they should at least pave the way therefor by such working agreements as will utilise to the best advantage so much regional distribution as at present exists instead of perpetuating a sort of chaos. I have been led to these reflections by a study of the pass-lists of the recent London matriculation, from which I see that nearly 3800 candidates entered. (Incidentally, the fact that under 33 per cent. passed suggests certain very serious criticisms, into which, however, I will not digress.) Now, obviously, we have evidence here of a very serious congestion; and it is clear that the congestion might be very considerably lessened if the regional system were applied at once, as a start, to matriculation candidates. I find that among the first 176 successful candidates there are scholars from (1) Beverley, Chesterfield, Halifax, Huddersfield, Keighley, Leeds, Spalding, and Sunderland; (2) Manchester; (3) Birmingham and Worcester; (4) Cardiff, Merthyr Tydvil, Pontypridd, and Swansea; and (5) Bath, *Bideford, Bridgwater, Clifton, Cheltenham, *Exeter, Sherborne, *St. Austell, and Taunton; and this list is not exhaustive, although it includes most of the names specially relevant to my immediate argument. Now it will be evident at once that candidates from all these places have *deregionalised* themselves, since they belong geographically (1) to the University of Leeds or Sheffield; (2) to the University of Manchester; (3) to the University of Birmingham; (4) to the University of Wales; and (5) to the University of Bristol; and it must be added that, if the proposed South-Western University should come into being, candidates from towns marked * would no longer be in the Bristol region.

Now much of this geographical confusion is already gratuitous, since systematisation has already gone thus far that various matriculations (including the Cambridge Previous and Oxford Responsions) are accepted, with varying qualifications and conditions, by various other universities as exempting from their own matriculations; so that already to a considerable extent a student may matriculate at his own regional university and then proceed to his degree in any one of many other universities; but the reciprocity and interchangeability are not even conditionally complete. It is true that in one important communication with which I have been favoured it is stated that "by the introduction in 1918 of school-leaving certificates *all entrance tests were pooled*"; but on inquiry and examination of the matriculation regulations of the various universities I find that this comforting statement is, unhappily, too sweeping. I will instance the most important exception. One of the newer universities—which is unique in having taken an entirely independent line and in making very practical recognition of the great educational fact (largely ignored by all other universities) that unchangeable inborn aptitudes vary very greatly, and that brains of equal quantitative value have profound qualitative differences—deviates from all the other universities in its matriculation requirements in that, first, and of least importance, it does not limit a candidate to five or six subjects, but merely stipulates for a minimum of two each in two groups and one in a third; secondly, it makes *no subject compulsory*; and, thirdly, it "passes" or "ploughs" by groups apparently instead of by individual subjects, with the very proper proviso that below a certain minimum no marks in any subject shall count towards its group-marks.

Now this scheme involves, to my thinking, an educational advance of tremendous significance, since it recognises the inborn qualitative differences and proclivities of boys' and girls' brains, and refuses to insist that round and square and hexagonal and triangular minds shall all be required to fit into one Procrustean or Chinese examination-gauge; but the apparent difficulty or impossibility of reconciling the requirements of this independent university with those of its far more tradition-bound fellows is obvious; and unless the difficulty can be overcome, either the regional system for matriculation must be abandoned, or those who matriculate at this university will find that they cannot proceed to a degree in various other universities as matriculated students.

Three courses are open:—First, all universities might adopt similar reformed regulations; but this suggestion may be dismissed as a counsel of perfection outside the range of present practical politics. Secondly, this innovating university might abandon its reformed ways and drop into line with subject-marks, instead of group-marks, and several compulsory subjects; but this, to my mind, would be educationally calamitous. Free, untrammelled experiment, spontaneity, and autonomy are essential to educational life and progress, whereas cast-iron uniformity and the repression of individuality in universities and schools are deadly and should be utter anathema. The third course obviates all difficulties. Let each university make its own regulations for its own matriculation, but let it regionally examine students in such wise as to grant the greatest latitude allowed by the most elastic scheme, and issue certificates qualifying for matriculation either in its own domain, or both therein and at various other universities, or at only certain universities, or at only one. Every university in the kingdom could then regionally matriculate students for every other, subject to such regulations as these: "Unless you pass in subjects x and y you cannot proceed to universities A, B, C, D; unless you pass in x and y and z you cannot proceed to E and F; unless you pass in w and x you cannot proceed to G," and so on.

When the pass conformed with the requirements of the examining university a certificate of matriculation at that university would be issued; when otherwise, a certificate entitling the student to matriculate at the universities specified therein. This suggestion assumes, of course, both that the papers set by each university in any subject reach the same standard, and that the percentages of marks qualifying for a pass are the same; and I believe that approximately such uniformity in England has already been obtained, except that the Previous and Responsions are apparently easier than the matriculation examinations of the other universities, although, with qualifications and conditions, they are, curiously enough, accepted by these.

Subject, then, to such very practicable working arrangements, and in view of the extent to which co-ordination already obtains, surely the universities should take another step forward and agree to delimit their respective areas and to refuse candidates for matriculation from another "region," and similarly, of course, to refuse to undertake tutorial classes for adults and extension-lectures in another region. As things are at present, London figures as a sort of poacher on the preserves of all its neighbours, since it holds its matriculation examinations at provincial centres all over the country, and sweeps into its net the natural matriculation prey of its sister (or daughter) universities—at the cost of the shocking congestion already described. Here clearly we find pre-regional practices surviving anachronistically in regional times. The explanation is that (1) originally there were no provincial universities, and therefore London most properly consulted the convenience of provincial students; and (2) the London matriculation long since attained a *kudos* that does not attach in the lay mind to the matriculations of the newer universities. The trouble, I suspect, lies not so much with those who intend to proceed to their degrees—since so many of the matriculations will secure their entrance to any of the universities, and the Final degree eclipses utterly any matriculation *kudos*—as with the large number who intend to go no farther, but desire the matriculation certificate as a proof that they have reached a certain standard of school education. Now, however, all these matriculations have been approximately standardised with the precise object of rendering these "First School certificates" equivalent; and all that is necessary in order to bring the lay public up to date is that the universities should proclaim this fact by delimiting their regions and refusing extra-regional matriculation candidates.

I anticipate no agreement with my views, but only contemptuous contradiction, from those who think in traditional grooves and have not realised the difference between 1920 and 1890 or 1860; but I submit that universities must play a vastly larger part in national life henceforward than in the past, must lead and direct and inspire education and research of all sorts and all grades, and must function as the pulsating heart and controlling brain, each of its own region; that their extra-mural activities in several directions must be enormously increased; and that only by covering the country with a network of regional universities, each responsible for its own region, can we enable each fully to develop its functions of guiding and inspiring secondary education and adult education and research *of all sorts* in its region.

I most specifically confine my proposals for regional distribution of candidates to the matriculation examination, not only because it will frequently happen that after schooldays a change of residence will bring the undergraduate into another region, but also because it has rightly been urged that each university, besides covering the general courses, should aim at making some one "school" a specialty, and that education would be hindered rather than helped, and energy dissipated, if every university sought to collect a few students in each of several uncommon subjects—*e.g.* tropical medicine or palæobotany—instead of bidding all the comparatively few students of each such subject betake themselves to whichever university may have been led to establish a special school or department for the study thereof; and because, as I have said, free experiment and varied curricula are eminently to be desired—given, of course, that all standards should be approximately equal in the sense that a given degree should always imply equivalent brains and equivalent training, and that educationally cheap and nasty degrees should be unknown—and every matriculated student from whatever part of the country should be free to enter whatever university best fitted his own inborn proclivities and mental bent.

In fine, I suggest that *divide et impera* must be the motto of the universities if education in its very widest sense is to hold true imperial sway.

FRANK H. PERRYCOSTE.

Higher Shute Cottage, Polperro, R.S.O., Cornwall, August 20.

Portraits of Myriapodologists.

YOUR correspondent, Mr. S. Graham Brade-Birks (NATURE, September 2, p. 9), will find a portrait of George Shaw in Thornton's "New Illustrations of the Sexual System of Linnæus," and a photo-portrait of J. E. Gray in "Portraits of Men of Eminence" (1863). Also large engraved portraits by Maguire of J. E. Gray (1851) and John Curtis (1850), both in the collection of the General Library of the British Museum (Natural History).

B. B. WOODWARD.

4 Longfield Road, Ealing, W.5, September 3.

Age and Growth Determination in Fishes.

By ROSA M. LEE.

FOR centuries past it has been known that the scales of fishes showed concentric rings, and later observers have concluded that from the number of these rings the age of the fish could be ascertained.

This discovery was, however, not developed to any great extent until the last ten or twenty years, during which several scientific observers definitely traced the connection between the number of rings on the scales and the number of years of life of certain fishes, the carp amongst freshwater fishes and certain Gadidæ amongst salt-water fishes having been intensively examined and providing a first proof of the correctness of the general theory. The salmon is another fish the economic value and the intrinsic interest of which led to particular attention being paid to its scales in connection with its life-history by many observers, both of professional and amateur status.

But it was the activities of the International Council for the Exploration of the Sea that gave the greatest impetus to the investigation of the age of fishes, and most systematic researches have been carried out with the purpose of correlating the knowledge gained from scale investigations as to the life-history of fishes with that derived from other methods of investigation undertaken by the Council. Amongst the workers of all the nations who have investigated this subject, the Norwegians stand pre-eminent for the very exhaustive researches they have carried on and for the original developments they have made in the methods used, both practical and theoretical. They have concentrated largely on investigating this question in the herring and salmon races, and their contributions to the knowledge of the age distribution and growth of these species have been very valuable.

A great deal of work on the same lines has been carried on by the other countries (including Great Britain) participating in the work of the Council, not only in Europe, but also in America, and the data now collected in regard to various species are extensive enough to enable us to judge the validity of the methods used and the importance of the results obtained.

The theory of age determination, briefly enunciated, is that the periodic quickening and slackening of growth in the fish brought about by the annual changes in the external conditions of their life, viz. summer and winter temperatures, with their accompanying abundance and scarcity of food, or of appetite for food, are reflected in the formation of the scales, and are mainly evident as rings marking the winter growth when development of the scale either slackens or wholly ceases. Such rings can be seen easily with the naked eye or with a low-power lens on the scales of many fishes, and those on the salmon scale illustrated in Fig. 1 furnish an example of the general appearance of winter rings.

Such rings are caused by the definite patterns into which the lines on the upper surface of the scale are formed under changing conditions. The arrangement varies for every species of fish, those of the same family being somewhat alike. Indeed, fish can be identified by their scales alone, as has been done on tinned fish purporting to be salmon.

There are striking differences in the appearance of the winter rings in the scales of certain well-known fishes. In the herring scale the striæ (surface lines) are close and equidistant; they pass from side to side, and appear to be broken by narrow, concentric, transparent rings. In the haddock there are small quadrilaterals arranged concentrically, occurring in zones of wide and narrow growth. In the smelt and the eel this state

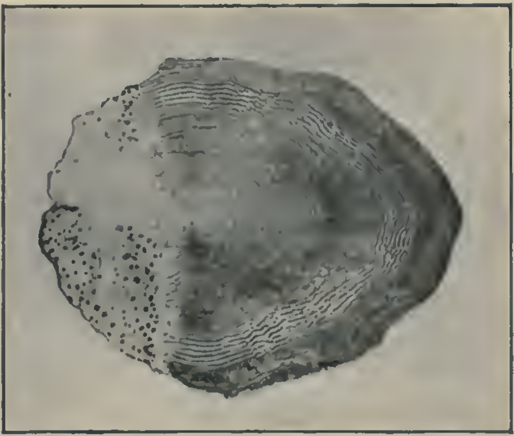

FIG. 1.—Winter rings on a salmon scale.

of wide and narrow zones can be traced, but only with difficulty, and the winter growth is indicated by clear concentric spaces, where the markings are either incomplete or wholly absent. In certain river fish also the winter growth can be traced by the unfinished lines rather than by the narrowing or closing in of the lines, which often marks winter growth.

Underlying all the differences in the patterns on the scales of the various fish a common principle of formation can be traced, and this is undoubtedly due (in normal circumstances) to the annual slackening or cessation of growth associated with winter conditions.

A study of many scales at all times of the year has shown that the discontinuity or incompleteness of the markings (striæ or platelets) may be a temporary characteristic of nearly all stages of growth, and that when growth is active (summer growth) the lines ultimately become complete, but that in the winter they remain incomplete, and therefore the discontinuity serves to mark out the winter growth, because the discontinuity becomes permanent, and leaves on the scales the blank spaces or broken lines which are the characteristic winter rings of certain species in addition to the narrowing of the spaces between the lines.

By counting the rings formed on the scale, the age of any individual fish can be ascertained. When large numbers of any one species are examined they can be grouped into "age classes" or "year groups" according to the number of rings. The average size of each group can be determined, and the difference between these sizes gives the first approximation to the amount of annual growth.

This general theory has been confirmed for several species, first by an examination of the growing edge of the scale throughout the season, when the rings have been seen in the course of development, and secondly by marking experiments on the fish (salmon, plaice, cod, etc.), when additional rings corresponding in number to the winters elapsed in the interval between marking and recapture have in every case been seen to be formed on the scales.

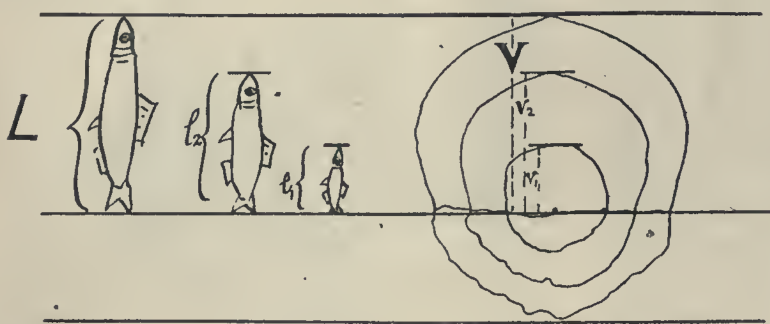

FIG. 2.—Proportional growth of a fish and its scale.

In practice there are, however, certain modifications and exceptions to the general theory which must be looked for and taken into account. What are known as "false rings" may occur. These bear a resemblance to winter rings, and are probably caused by sudden changes in environment, such as a change of temperature, lack or abundance of food, or even by the fish migrating from one part of the sea to another. These rings can generally be distinguished from true rings in the scales of fishes the habits of which are known. For instance, in salmon there is frequently a grouping of close lines in the middle of the third summer, known as a "summer check."

In very old fish the rings are close together near the edge, and it is difficult to make out their number with exactitude. It may sometimes happen that the latest rings become fused together, and the total number then appears less than those shown on the bony and opercular structures of the same fish.

Results of age determinations of many samples of fish have been studied from the mathematical probability point of view to ascertain whether such groups have a probable or natural variation of size, and whether groups of fish of the same ascertained number of rings taken under similar conditions are sufficiently alike in size grouping to give a high probability of being of the same age. These mathematical tests have confirmed the theory that on the average the age determinations of certain species of fish (salmon and herring) are correct up to five or six years of life—that is, those years when they are of most economic importance.

These methods of age determination enabled observers to deduce the approximate growth rates of fish by comparing the sizes of fish of known age. Growth curves so deduced generally rose rapidly from zero for the first two or three years of life, and then the rate of increase fell off rapidly as the fish grew older.

Later researches have demonstrated that this falling off in the growth rate in such fish as herring and plaice and others is not wholly due to a normal slackening in the development, but is made greater by the fact that in several species a segregation according to size takes place, the larger fish of the youngest groups leaving their associates and joining shoals of older fish, generally in deeper water. Such a segregation has been found to take place at the onset of maturity in certain species. Thus it follows that the youngest year groups in the samples are represented only by the larger individuals of those groups, and their average length is higher than those of the complete year group.

When such selection of size occurs, the average sizes of successive age groups are not strictly comparable with one another.

Norwegian investigators developed the method of ascertaining the growth of individual fish by measuring the comparative distances between the rings on the scales, on the assumption that the scale grows in length in proportion to the length of the fish. Fig. 2 shows a fish of length L with an enlarged image of its scale. The scale is measured from its centre along the main axis, and also to the edge of the winter rings, giving the values V (length of scale), v_1, v_2, etc. (lengths from centre to end of first, second winter rings, etc.). If exact proportional growth is assumed between the fish and its scale, it is evident from the parallel lines in the diagram that $l_1 : v_1 :: L : V$, and the lengths at previous winters (l_1, l_2, etc.) are found from the simple formulæ

$$l_1=\frac{v_1}{V} . L, \quad l_2=\frac{v_2}{V} . L, \text{ etc.}$$

Such a method enables the data as to growth to be multiplied to a very great extent, and should therefore be most valuable in detecting good and bad years of growth, which can be associated with known physical conditions, with the onset of maturity or even with migrations into different waters, and as such they have enormous value.

But, after studying the results obtained, certain investigators have doubted the validity of this method of ascertaining growth. It was noticed that in all species so investigated the calculated lengths for the first and succeeding winters became successively less and less as they were found from older and older fish, and other apparent discrepancies were pointed out by different observers. As a matter of fact, the above method gives only a first approximation to the actual lengths to which the fish grows at the end of each winter of life. It is based on the assumption that the lengths of the scale are themselves proportional to the length of the fish—a closer approximation (but still an approximation), for the calculation is given by taking the increments of growth of the scale as proportional to the increments of growth of the fish, starting from the point at which the scale first appears, which is in most cases an amount sufficiently appreciable to affect the calculations of the first two or three winter lengths considerably.

In Fig. 3 the average relations in the observed lengths of the scale and the corresponding fish, and in the observed lengths of the fish and the corresponding scales, are shown by the dots and crosses respectively.

A mathematical relation can be found by combining all the corresponding measures of scales and fish. This is known as a correlation coefficient, and in the case depicted was very high, viz. $r=0.95$. The points lie very nearly on straight lines, known as "regression lines," the mathematical equations to which are $L=4.8V+3$ and $V=0.19L-0.36$. From the first of these equations the length of the fish can be calculated when the length of the scale is known from measurements.

The general form of this equation for any series of measurements of fish and their scales is $L=aV+c$, the constant term c corresponding to the length at which the scale begins to grow. In the case of North Sea herring c is about 3 cm.

As in practice only relative lengths of the winter rings are measured on the scale, the constant a in the equation can be eliminated, and the calculated lengths to any previous winter (L_1, L_2, etc.) derived from the equation put in the form

$$L_1=c+\frac{v_1}{V}(L-c), \text{ etc.}$$

The results obtained by the use of this formula approximate more closely to values derived from observation than in the case of the original formula when c is not taken into account, and the growth measures calculated in this way can therefore be assumed to be a closer approximation to the truth.

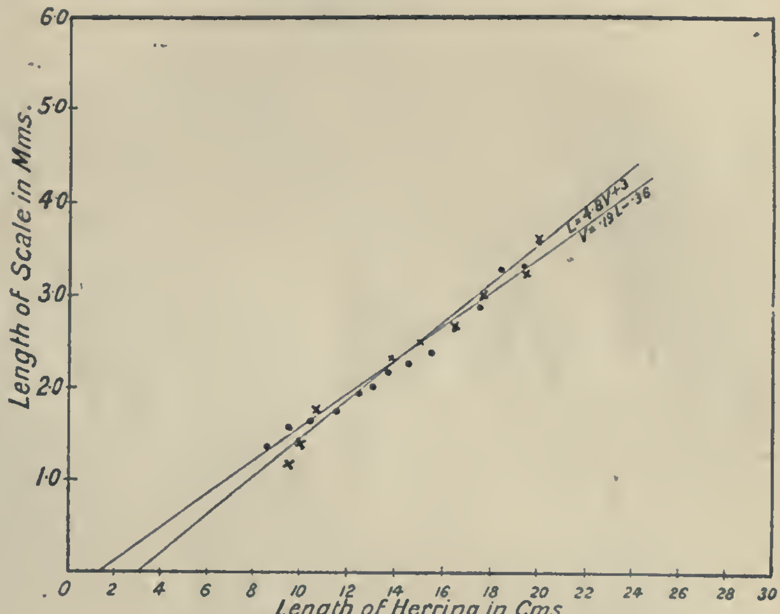

Fig. 3.—Showing average relations between measurements of fish and their scales.

In all cases of age and growth determination individual records may be wrong, owing to one or other of many difficulties that may occur in deciphering the scale, but the latest work on the subject has shown that *average* values, both of age distribution in a sample and of amount of growth, are approximately correct.

The Structure of the Atom.

By C. G. Darwin.

I.—*Atomic Number.*

The study of the interior structure of the atom was initiated about twenty-five years ago by J. J. Thomson's discovery of the electron. Electrons are particles of negative electricity of charge 4.77×10^{-10} electrostatic units and mass 9.0×10^{-28} gr., and they were shown to be constituents of every type of matter. Some years previously Thomson had shown on theoretical grounds that any charged body should possess extra mass on account of its charge, and these two facts taken together suggested the possibility of an electrical theory of matter, whereby all mass should be electromagnetic in origin, and all the properties of matter should be reproduced by the interactions of electrons and positive charges, the latter at that time quite unknown. It is not possible to dwell here on the earlier atom models (such as those of Thomson or Ritz) which were devised on these lines. They had a certain measure of success in explaining some of the properties of matter; but we can now see that there was insufficient experimental knowledge at that time, and also that no theory could possibly work which was based on the old classical ideas of dynamics, as these are certainly inadequate to deal with atomic problems.

As electrons were known to be common to all matter, it was natural to ask how many were contained in each type of atom. The mass of an electron is about 1/1840 of that of a hydrogen atom, and therefore this atom cannot contain more than 1840 electrons. For other elements the corresponding upper limit is given by multiplying the atomic weight by 1840. Thus in all cases a very wide field of choice is left. The attack on the problem was not possible until the development of X-rays and radio-activity had reached a certain stage of advancement, for ordinary chemical and physical methods are quite incapable of penetrating beyond the surface layers of the atom, whereas both X-rays and the radio-active particles are so powerful that they can go right through the atom, and from their behaviour in passing we can deduce a certain amount about its interior. With both the method consists in observing the phenomenon of scattering; that is to say, a narrow parallel beam is sent through a plate, and the amounts are found which are thrown off at various angles. Theory tells us how much a single electron should scatter, the number of atoms in the plate is known with some accuracy, and so we can count the number of electrons in each atom, if we assume that the scattering is due to them alone. When this method is applied with either X-rays or β-particles (the latter are simply electrons moving at a high speed), certain theoretical complications make the results rather inaccurate, but in both cases the experiments clearly indicated that the number of electrons in the atom was of the same general magnitude as the atomic weight. This was found for several elements ranging in weight between carbon and gold. So our first upper limit to the number of electrons in the atom was vastly in excess, and no considerable fraction of the mass of an atom is contributed by its electrons.

The experiments with α-particles were far more definite. An α-particle is simply a helium atom, carrying a positive charge equal to that of two electrons, and moving at a very high speed. As the atomic weight of helium is 4, it is seven thousand times as heavy as an electron. When an α-particle passes an electron the attractive force sets the electron in motion, and the reaction of this force gives the α-particle a small deflection and reduces its velocity slightly. On account of the smallness of the effect of a single electron, great uniformity is obtained in the average, and the number of electrons in an atom can be counted by observing either the scattering of the beam or else the rate at which the particles lose their velocity. Both give the same result, that the number of electrons in an atom is approximately half its atomic weight.

But the experiments on the scattering of α-particles contained the germ of far more important information. For in the course of them it was observed that a certain small fraction of the α-particles underwent large deflections. A few even were thrown right backwards. Now this fraction, though small in itself, was out of all proportion large compared with what could be given by the cumulative effect of a large number of collisions with electrons. Rutherford showed that the only reasonable hypothesis to account for this type of scattering was to suppose that the large deflections were produced in a single step. In this way he was led to put forward the nucleus theory of the atom, now universally accepted. According to this theory practically the whole mass of the atom is carried by a nucleus of very small dimensions (at most 10^{-12} cm.) which has a charge of positive electricity equal to some multiple of the electronic charge. This nucleus is surrounded by a cloud of electrons of just such a number as to neutralise its charge. Each element has a different nuclear charge, and (to anticipate some results that we shall come to later) the value of this nuclear charge completely determines all the chemical characters of the element. Radioactive properties belong to the nucleus, as well as mass, while chemical and spectroscopic properties are attributed to the electrons of the cloud, and are only indirectly controlled by the nucleus because it determines the number and arrangement of these surrounding electrons. The dynamical structure of this planetary system was left unspecified, and remains to this day almost unknown.

Now consider the bearing of this theory on the question of scattering. The α-particle is itself the nucleus of a helium atom. In passing through matter most of the particles will not go very near any nucleus, and so will behave in the way we have already discussed. But the paths of a few will take them near some nucleus, and large repulsive forces will be developed between the two positive charges. Most atoms are much heavier than α-particles, and so the latter will describe hyperbolas according to Newton's laws, and pass off in new directions. It is a simple matter to calculate the number of particles to be expected at any inclination to the original beam in terms of their initial velocity and the charge on the nucleus. The comparison with experiment, therefore, first furnishes a test as to whether the law of force has been taken correctly, and then provides a value for the nuclear charge. In both particulars the experiments fully bore out the prediction, and it was found that the nuclear charge (measured with the electronic charge as unit) was about half the atomic weight for the lighter elements, and rather less than half for the heavier.

Table of Atomic Numbers of the Elements.

	Hydrogen **1.** H, 1·008 1·008									
Helium **2.** He, 4·00 4	Lithium **3.** Li, 6·94	Beryllium **4.** Be, 9·1	Boron **5.** B, 10·9 10, 11	Carbon **6.** C, 12·00 12	Nitrogen **7.** N, 14·01 14	Oxygen **8.** O, 16·00 16	Fluorine **9.** F, 19·00 19			
Neon **10.** Ne, 20·2 20, 22	Sodium **11.** Na, 23·00	Magnesium **12.** Mg, 24·32	Aluminium **13.** Al, 27·1	Silicon **14.** Si, 28·3 28, 29	Phosphorus **15.** P, 31·04 31	Sulphur **16.** S, 32·06 32	Chlorine **17.** Cl, 35·46 35, 37			
Argon **18.** A, 39·88 36, 40	Potassium **19.** K, 39·1	Calcium **20.** Ca, 40·07	Scandium **21.** Sc, 44·1	Titanium **22.** Ti, 48·1	Vanadium **23.** V, 51·06	Chromium **24.** Cr, 52·0	Manganese **25.** Mn, 54·93	Iron **26.** Fe, 55·85	Cobalt **27.** Co, 58·97	Nickel **28.** Ni, 58·68
	Copper **29.** Cu, 63·57	Zinc **30.** Zn, 65·37	Gallium **31.** Ga, 69·9	Germanium **32.** Ge, 72·5	Arsenic **33.** As, 74·96 75	Selenium **34.** Se, 79·2	Bromine **35.** Br, 79·92 79, 81			
Krypton **36.** Kr, 82·92 78, 80, 82, 83, 84, 86	Rubidium **37.** Rb, 85·45	Strontium **38.** Sr, 87·83	Yttrium **39.** Y, 88·7	Zirconium **40.** Zr, 90·6	Niobium **41.** Nb, 93·5	Molybdenum **42.** Mo, 96·0	— **43.**	Ruthenium **44.** Ru, 101·7	Rhodium **45.** Rh, 102·9	Palladium **46.** Pd, 106·7
	Silver **47.** Ag, 107·88	Cadmium **48.** Cd, 112·4	Indium **49.** In, 114·8	Tin **50.** Sn, 118·7	Antimony **51.** Sb, 120·2	Tellurium **52.** Te, 127·5	Iodine **53.** I, 126·92			
Xenon **54.** Xe, 130·2 128, 130-1-3-5	Cæsium **55.** Cs, 132·81	Barium **56.** Ba, 137·37	Lanthanum **57.** La, 139·0	Cerium **58.** Ce, 140·25	Praseodymium **59.** Pr, 140·6	Neodymium **60.** Nd, 144·3	— **61.**			
	Samarium **62.** Sa, 150·4	Europium **63.** Eu, 152·0	Gadolinium **64.** Gd, 157·3	Terbium **65.** Tb, 159·2	Dysprosium **66.** Ds, 162·5	Holmium **67.** Ho, 163·5	Erbium **68.** Er, 167·7			
	Thulium **69.** Tu, 168·5	Ytterbium **70.** Yb, 173·5	Lutecium **71.** Lu, 175	Keltium **72.** Kt	Tantalum **73.** Ta, 181·5	Tungsten **74.** W, 184·0	— **75.**	Osmium **76.** Os, 190·9	Iridium **77.** Ir, 193·1	Platinum **78.** Pt, 195·2
	Gold **79.** Au, 197·2	Mercury **80.** Hg, 200·6 197–204	Thallium **81.** Tl, 204·0 IV.	Lead **82.** Pb, 207·2 XI.	Bismuth **83.** W, 208·0 V.	Polonium **84.** VII.	— **85.**			
Emanation **86.** III.	— **87.**	Radium **88.** Ra, 226·0 IV.	Actinium **89.** Ac II.	Thorium **90.** Th, 232·15 VI.	U.X₂ **91.** II.	Uranium **92.** U, 238·2 II.				

The atomic numbers were mostly fixed by the less direct method of Moseley, which will be described later. For convenience the "isotopes" (also to be discussed later) are given in the table. Thus, as an example, read:—Chlorine, atomic number **17**, symbol Cl, atomic weight by chemical methods 35·46, composed of two isotopes 35 and 37. In the case of the radio-elements (**81–92**) the evidence is of a different kind, and the roman numeral gives the number of them believed to exist. The nomenclature of some of the rare earths (**69–72**) is not yet standardised. The names here are those used by Moseley. Some of these elements, though detected by their X-ray spectra, have never been isolated. As points of some interest, observe that in three cases (A and K, Co and Ni, Te and I) the order of atomic weights is wrong, while the periodicity of the chemical properties corresponds to the atomic number Observe also the five missing elements—**43, 61, 75, 85, 87**; the properties of which can be predicted with fair confidence from the Periodic Law. A curious relation, pointed out by Rydberg, is that the atomic numbers of all the inert gases are given by taking the series $2(1^2+2^2+2^2+3^2+3^2+4^2+\dots)$ and stopping the summation at any term.

This method of determining the number of electrons in the atom is by far the most direct yet devised, as the interpretation of the experiments does not involve the rather difficult averaging necessary for the compound scattering produced by the electrons.

Now if we make a table of all the elements arranged in order of atomic weights, as is done by chemists for the study of the Periodic Law, and if we number them in this order, starting with hydrogen at 1, helium at 2, and so on, as on p. 53, it will be seen that the resulting numbers are always in the neighbourhood of half the atomic weight. The nuclear charge is by hypothesis some multiple of the electronic charge, and by experiment is about half the atomic weight, and so we are almost forced to suppose that the ordinal number of an element in the table is the same as the number of electronic charges on its nucleus. We do not anticipate an exact correspondence throughout the table, because there may be (and in fact are) gaps in it which represent hitherto undiscovered elements. But apart from this we arrive at the conception of an *atomic number* for each element. The atomic number of an element is defined as the number of positive electronic charges carried by its nucleus, or, which is the same thing, as the number of electrons surrounding this nucleus.

(To be continued.)

Obituary.

CANON C. H. W. JOHNS.

BY the death of the Rev. C. H. W. Johns, Master of St. Catharine's College, Cambridge, and Canon of Norwich, Assyriology has lost another of its most prominent representatives in this country. It was almost exactly a year after the death of Prof. L. W. King that Canon Johns passed away. He had been noted as an Assyrian scholar for many years past; held the post of lecturer in Assyrian at his college of Queens', in the University of Cambridge, for fourteen years; and preceded Prof. King as Assyrian reader at King's College, London. These lectureships he vacated on his appointment as Master of St. Catharine's in 1909. The duties of the head of a college in no way interfered with the continued prosecution of his Assyrian studies, and to the last Dr. Johns was at work on the cuneiform inscriptions to which he had devoted a large part of his life. He was an excellent decipherer of the tablets, and had had much experience as a student of Ashurbanipal's library in the British Museum, to the officials of which, and especially to the late Prof. King, he was always *persona grata* and a valued colleague in science. His most notable publication is probably his "Assyrian Deeds and Documents," published in 1898—a series of copies and translations of a large number of cuneiform legal and other records preserved in the British Museum. He also wrote on the famous legal code of Hammurabi, delivered the Schweich Lectures on the relations between the Laws of Babylonia and the Laws of the Hebrew peoples, and contributed articles on Mesopotamian law and history to various scientific journals and dictionaries, notably to the "Encyclopædia Biblica." His death is a great loss to the scientific study of Mesopotamian archæology.

H. R. HALL.

PROF. ADAM POLITZER, whose death has just been announced from Vienna, was recognised in all lands as the leading specialist of his time in diseases of the ear. He was born in Hungary on October 1, 1835, and, taking his medical degrees at the University of Vienna in 1859, went abroad to study the anatomy and diseases of the ear, coming to London to work at the pathology of the ear under Mr. Joseph Toynbee, F.R.S. Returning to Vienna, he quickly established himself as the leading exponent of the newest learning concerning the organ of hearing and its defects, and his growing fame drew medical men to Vienna from all parts of the civilised world. The secret of his success was that he founded his methods of treatment on a first-hand knowledge of the structure, action, and pathology of all parts of the ear. He sought to give to the practice of the aural surgeon a foundation on fact, and not the least of his discoveries were made in the fields of normal anatomy.

THE death of SIR CHARLES LYALL leaves a gap in the ranks of the older school of Orientalists, in which field he will be remembered rather than as an eminent Indian administrator. Sir Charles became a member of the Civil Service in the United Provinces of Agra and Oudh in 1867, and, without much experience of district work, he was absorbed in the Provincial Secretariat, and then went to Simla and Calcutta. Much of his service was passed in Assam, of which province he became Chief Commissioner. Transferred to the Central Provinces, his training in administration failed to prepare him for the emergency of the great famine of 1897, and he was removed to the India Office as Secretary of the Judicial and Public Department. Here he was able to resume his work on Indian languages, particularly Hindustani, and he showed his profound knowledge of Arabic by numerous translations of its poetic literature, which he discussed in successive editions of the "Encyclopædia Britannica." Sir Charles Lyall was a tower of strength to the Royal Asiatic Society, of which he was vice-president, working with Orientalists like James Kennedy and Vincent A. Smith, both of whom recently died. His services to literature were rewarded by several honorary degrees, and by the coveted distinction of fellowship of the British Academy.

Notes.

On August 31 and September 1 the centenary of the discovery of electromagnetic action by the Danish physicist, Hans Christian Oersted, was celebrated at Copenhagen. Meetings were held in the Town Hall and University, at which many Scandinavian men of science were present, and the occasion was marked by the publication of some of Oersted's scientific correspondence. It was during the winter of 1819–20 that Oersted observed that a wire uniting the ends of a voltaic battery affected a magnet placed in its vicinity, and after prosecuting his inquiries some months longer, in July, 1820, he published his Latin tract, "Experimenta circa effectum Conflictus Electrici in Acum Magneticum." The importance of his discovery received instant recognition. Ampère, Arago, and Davy all seized on the idea, and four months after the publication of his tract Oersted was elected a foreign member of the Royal Society and awarded the Copley medal. Efforts to connect magnetism with electricity had hitherto met with little success, and Wollaston, in his discourse as president of the Royal Society, referring to Oersted's discovery, expressed the hope that "the gleam of light which thus beams upon us may be the dawn of a new day, in which the clouds which have hitherto veiled from our sight the hidden mysteries of light and heat, of electricity and magnetism, may be dispelled." Oersted, who was the son of a country apothecary, originally studied medicine, but turning his attention to chemistry and physics while at Copenhagen University, he was in 1806 appointed to the chair of physics, and he held that position until his death in March, 1851, at the age of seventy-three. Known alike for his genial and kindly nature and for his scientific labours, he was the author of some two hundred memoirs, and received many honours at home and abroad. Twenty-five years after his death a bronze statue of him was erected on the old fortification of Copenhagen.

The joint committee appointed by the Illuminating Engineering Society to inquire into the subject of eye-strain in kinema theatres has now presented an interim report to the London County Council. The committee consisted of representatives of the Illuminating Engineering Society, the Council of British Ophthalmologists, the Physiological Society, and the kinema industry, and also received the help of various officers of the London County Council. Its main conclusions are concerned with the undue proximity of seats to the screen as a cause of eye-fatigue. The committee expresses the opinion that a high angle of view is one of the most important causes of eye-strain. It is accordingly recommended that the angle between the horizontal plane passing through the observer's eye and the plane containing the observer's eye and the top edge of the picture should not exceed 35°. This is, roughly, equivalent to specifying that the ratio between the distance of the nearest seats from the screen and the height of the top of the picture above eye-level should not be less than 1 : 43. A second recommendation limiting to 25° the obliquity of view from the sides of the theatre is also made. The conclusions are based on actual experience in a number of kinemas in London, and will doubtless be accepted as moderate in scope. Various other matters, such as the origin of flicker, the effect of imperfect films and apparatus, and the conditions of artificial lighting to be provided in halls, are also dealt with, although formal conclusions are not presented at this stage. With proper precautions it appears that the provision of a low general illumination in halls is consistent with a satisfactory image on the screen. Such inquiries, besides being in the public interest, should ultimately also be for the benefit of the kinema industry, and we are glad to note that several representatives of the industry shared in the investigation.

Prof. J. B. Farmer, professor of botany in the Imperial College of Science and Technology, has been appointed by an Order of Council to be a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

We learn from *Science* of August 20 that Dr. George Ellery Hale, director of Mount Wilson Observatory, has been elected a foreign member of the Società Italiana delle Scienze, Rome, in succession to the late Lord Rayleigh.

Severe earthquake shocks occurred at Milan, and in other parts of Northern and Central Italy, shortly before eight o'clock on September 7. The centre of the disturbance seems to have been in the province of Massa Carrara, where several villages have been much damaged and the small town of Villa Collemandina has been destroyed.

The next meeting of the Association of Economic Biologists will be held on Friday, September 24, at the Royal Botanic Gardens, Kew. At 2.30 p.m. a discussion will be opened on problems of susceptibility or immunity to disease in plants, the following being the principal speakers :—A. Howard, The Relation of Soil Aeration and Soil Temperature to Disease in Plants; E. S. Salmon, The Relation of Climatic Factors to Disease in Plants; and F. T. Brooks, Immunity to Disease in Plants as a Mendelian Factor.

At a meeting of delegates appointed by the scientific academies of the Allied nations held in Brussels in July, 1919, an International Research Council was formed for the co-ordination of work and effort in the various branches of science and its applications. Each country, by means of its national academy or national research council or its Government, can take part in the scheme. We gather from an address on the organisation of research delivered before the Association of American Universities by Dr. J. R. Angell, and reproduced in the July number of the *Scientific Monthly*, that the United States has established a National Research Council to deal with the organisation and conduct of research in that country. While in Germany the work was done most effectively by an autocratic Government, it was felt that in a democratic country an enterprise of this type could only meet with conspicuous success if freed from Government control. The funds are provided from the Rockefeller Foundation and other private sources, and arrangements with the universities for the training of research workers, for the organisation of research, and for the supply of information regarding current research have already been made.

THE Nile Projects Commission, appointed to consider the proposals of the Egyptian Ministry of Public Works for improving the regulation of the Nile discharge with the view of extending the cultivable area of Egypt, has issued an interim report, in which, dealing first with the ethical charges brought by Sir William Willcocks and Col. Kennedy against Sir Murdoch Macdonald, the Adviser to the Egyptian Ministry of Public Works, the Commission states that on a careful consideration of all the evidence the members are unanimously of opinion that there has been no falsification or intentional suppression of records or any fraudulent manipulation of data. A study of the projects as described in "Nile Control," the official statement by Sir Murdoch Macdonald, has further led the Commission to the conclusion that, considered strictly from an engineering point of view, the White Nile dam, the Gezireh irrigation scheme and Blue Nile (Sennar) dam, and the Nag Hammadi barrage should be carried out at once. A final report is promised, in which will be considered at length the Commission's observations made in Egypt, the character of the data, the criticisms received and an examination of the evidence given on oath, and other matters. The members of the Commission are Mr. F. St. John Gebbie (president), Prof. H. T. Cory, and Dr. G. C. Simpson.

MR. J. J. JOICEY has acquired for the Hill Museum, Witley, the collection of Lepidoptera formed by Mr. H. J. Elwes, as well as the large collection of Heliconius formed by the late H. Riffarth. The museum has lately also received large collections of Lepidoptera from Central Africa, obtained by Mr. and Mrs. T. A. Barns, who have recently returned from a twelve months' trip undertaken on behalf of Mr. Joicey. Mr. Barns has recorded many interesting observations on the bionomics of the Lepidoptera collected. Some remarkable kinematograph films were taken *en route* of both geographical and entomological interest. A report on the results of this expedition is in progress. The museum has also in preparation papers on the Lepidoptera of Hainan, of the Schouten Islands, of Dutch New Guinea, Misol, Aru, Key, Tenimber, Obi, and Sula Islands, and a report on the Lepidoptera collected by Messrs. Pratt in the mountains of Central Ceram. Mr. Joicey has now sent the three brothers Pratt to Dutch New Guinea. They have reached the mountains in an area south of Geelvinck Bay, entomologically unexplored, and a consignment of specimens has already been dispatched. It is expected that important zoological results will be obtained by this expedition.

IN the Journal of the Royal Anthropological Institute (vol. xlix., July–December, 1919) Mr. S. Hazeldine Warren records the discovery at Graig-lwid, Penmaenmawr, of an important prehistoric site where the manufacture of axes of the Neolithic type was extensively carried on. Penmaenmawr Mountain and Graig-lwid form an oval intrusion of igneous rock, which is extensively quarried for road-metal and building stone. Neolithic remains are generally scarce in North Wales, but Sir John Evans records the discovery of some axes at Dwygyfylchi, in Carnarvonshire, the adjoining village to Penmaenmawr. The axes were made of scree material—that is to say, angular blocks of rock broken up by frost along its natural joint-planes. It is certain that there was a very large output of axes from this factory, and some of them must have passed to long distances in the course of barter and along trade routes during hunting expeditions or hostile raids, tribal migrations, and the like. It is possible that some examples in collections made of felsite or felstone may ultimately be traced to this factory.

IN the Journal of the Torquay Natural History Society (vol. ii., No. 6, 1920) Mr. H. J. Lowe discusses "The Needles of Kent's Cavern with reference to Needle Origin." He thinks that the modern implement originated in prehistoric times in the course of attempts made to sew skins together for use as clothing. The simplest method is to attempt to push the thread through when piercing the hole for it, and the advance made was by getting the idea of a hole in the awl through which the thread could go and be thrust through the skin with the awl or bodkin. In support of this theory a bone needle has recently been found in Kent's Cavern, which Mr. Lowe regards as "an unique specimen of Palæolithic man's bone implement, made for use as a needle." In this specimen "its blunt end will permit strong pressure and twisting by the end of the thumb without abrading the skin or causing a sore, and with one thread passing before the thumb, to be held taut with the other by the closed three fingers, the implement could be held firmly to the thumb and vertically to the skin by one hand, while the other would be free for holding and adjusting the skin while the needle was being pushed through it." It will be interesting to ascertain whether other examples of such an implement are available in collections, and if Mr. Lowe's view is correct.

WE have recently received the first volume (124 pp.) and Nos. 1–2 (32 pp.) of the second volume of *Bollettino della Società Italiana per lo Studio della Alimentazione*, published from the Museum of Natural History in Florence. The bulletin contains original articles on problems connected with food and nutrition —*e.g.* the milk-food of infants, the present soldier's ration in Italy, the culture of carp, and the preservation of hen's eggs. About half of each issue is devoted to abstracts of memoirs on the chemistry and physiology of nutrition, the analysis of food, adulteration, dietetics, the production and preparation of food, the nutrition of animals, and diseases of man and animals arising from food, *e.g.* deficiency diseases.

IN the *Lancashire and Cheshire Naturalist*, vol. xiii., No. 2, August, 1920, Miss Annie Dixon reports on the gatherings of protozoa made from a pond in Didsbury, from September, 1918, to March, 1919, and appends a table of the species found, about 100 in number, showing in which months they occur. A previous report dealt with the protozoan fauna of this pond during the period March to September, 1918. Among the more noteworthy species recorded may be mentioned *Archerina Boltoni*, which was very common during one week in April, 1918, but has not reappeared; and *Mastigamoeba aspera*, which was found in small numbers in September and October, 1918. It is to be hoped that the study of the protozoa of this pond and the recording of the seasonal occurrence of the various species will be continued.

ZOOLOGISTS, and especially field-naturalists, will be interested in a short paper on the occurrence of Protohydra in England, by Prof. S. J. Hickson, in the current issue of the *Quarterly Journal of Microscopical Science* (vol. lxiv., part 4). *Protohydra Leuckartii* was discovered rather more than half a century ago, and, although apparently very rarely met with since, it has always been regarded with especial interest as one of the simplest—though not necessarily the most primitive—of the Cœlenterata, being, in fact, a Hydra without any tentacles. It has now turned up in abundance in pools in the tidal marshes of the River Hamble, near Southampton, and has also been recorded from the Laira River, near Plymouth. Unfortunately, though it has been observed by Prof. Hickson and Mr. Herbert Ashby for four successive years, no new light is forthcoming as to its life-history, no medusoids and no sexual method of reproduction, but only transverse fission, having been observed.

A MONOGRAPH of the South Asian, Papuan, Melanesian, and Australian frogs of the genus Rana, by Dr. G. A. Boulenger, forms vol. xx. (226 pp., June, 1920) of the Records of the Indian Museum. Dr. Boulenger has grouped the series, so far as possible, according to their probable phylogenetic relationships, and in order to do this has laid down the characters which might be expected to occur in a theoretical prototype from which phyletic lines may be drawn up. Among Asiatic species he regards *Rana hexadactyla* as the nearest approach to the ideal prototype. He groups the 125 species considered into seven natural sections, the first of which is the *hexadactyla*-section from which three others can be derived. The remaining three sections are derived from other ancestral sources. A table of the characters of the nine subgenera of Rana and excellent synoptic keys of the species are given. Detailed descriptions of the species follow, and tables are supplied giving measurements of the different parts of the body of adult and half-grown specimens in order to convey exact information on these important matters, and also to show the amount of individual variation.

PAMPHLET No. 11 of the Economic Series published by the British Museum (Natural History) has recently appeared. It is written by Dr. Gahan, the keeper of the entomological department, and deals with furniture beetles, their life-histories and preventive measures. Not infrequently articles of furniture, or some part of the woodwork in the house, are seriously damaged by the larvæ of certain beetles, of which we have about five species in this country. The common furniture beetle (*Anobium punctatum*, De G.) is the most usual enemy; the death-watch beetle (*Xestobium rufovillosum*, De G.) seldom attacks movable furniture, and more usually affects the timbers of old houses, etc.; while the powder-pest beetles (Lyctus) mostly affect sapwood, and, unless treated with a preservative beforehand, this part is unsuitable for furniture-making. The above types of beetles are well described in this useful little brochure, and clearly figured. Wherever it can be safely applied, treatment by heat is one of the best methods of dealing with affected furniture. In other cases resort has to be made to fumigation with a poisonous gas or vapour. As a third alternative, direct application of a liquid, such as benzene, carbon tetrachloride, or terebene, may be adopted. Anyone troubled with these pests is advised to obtain this pamphlet, which can be purchased at the Museum for the sum of 6*d*.

M. MEUNISSIER has published (*Journal of Genetics*, vol. x., No. 1) a short account of some genetic results obtained by the late M. Philippe de Vilmorin on the colour of the hilum or point of attachment of the pea. One variety of garden pea has a black hilum or "eye," and in crosses with other varieties and species this was found to behave as a simple dominant. In several crosses of varieties in which both parents had an uncoloured hilum, the black hilum appeared in the offspring—in some cases in all the offspring, in others in only a portion of them, and in still others only a few seeds developed the black hilum. Whether such cases are to be looked upon as variations, or, in the latter case, as bud mutations, can only be determined by further breeding experiments. They represent an interesting departure from the usual Mendelian behaviour.

BEFORE the war the medical opium trade was largely in the hands of Turkey, and the Indian opium poppy, although belonging to the same species (*Papaver somniferum*) as the Turkish, was found to have a lower morphine content. In order to replace the foreign product by one produced within the Empire, an effort is being made to produce by breeding experiments a race with a high content and a good yield. Messrs. H. Martin Leake and B. Ram Pershad (*Journal of Genetics*, vol. x., No. 1) expect, by selection and crossing of the numerous Indian varieties of opium poppy, to produce a race with the desired qualities. The preliminary paper deals with the numerous colour varieties. The colour patterns are independent of opium content, but are a useful index of purity in the various races. Chemical investigations have disclosed races yielding as much as 18 per cent. morphine.

THE first of the Memoirs of the Botanical Survey of South Africa has been issued by the Union Department of Agriculture. It comprises an account of the Phanerogamic flora of the Divisions of Uitenhage and Port Elizabeth by Dr. S. Schonland. In July, 1918, an Advisory Committee for the Botanical Survey of the Union was appointed by the Minister of Agriculture, consisting of botanists from each of the four provinces, with the chief of the division of botany and plant pathology as director of the Survey. The botanists comprising the Committee are each in charge of different administrative areas into which the Union has been divided for purposes of the Survey. It was agreed that as a basis of the Survey the preparation of regional floras should be taken in hand and local vegetation surveys prepared, and the present contribution is the first of these regional floras.

PROF. J. C. BRANNER has furnished a much-needed summary of the geology of Brazil, together with a coloured map on the scale of 1 : 5,000,000 (Bull. Geol. Soc. America, vol. xxx., p. 189; second ed., April, 1920). The included bibliographies enable the reader to supplement on any special line the immense amount of material here brought together in a condensed form from the author's own experience. Among the plates is a handsome photograph of a striated boulder from the Permian beds of São Paulo.

MR. H. P. WHITLOCK (*Amer. Journ. Sci.*, vol. xlix., p. 259, 1920) has constructed and described a model for the demonstration of any point-system in atomic spacing within crystals, the atoms being represented by perforated wooden beads, which are obtainable in six colours from dealers in kindergarten requisites. Glass rods are used for their support, and these are passed through holes appropriately punched in two horizontal plates of tin set in a frame. Only two types of frame are required by the crystallographic systems.

WE know, from such valuable publications as Collet's "Alpes calcaires entre Arve et Rhône," that geology is honoured by the *Société de Physique et d'Histoire Naturelle de Genève*. In the *Compte rendu des séances* for April to July, 1920, various authors discuss such topics as details of Alpine structure; the glacial origin of the Petit Lac of Geneva, involving the question of the capture of the Rhône Valley ice by the Arve basin, and the end of the struggle between the Arve and Rhine for the possession of the waters of the upper Rhône; the green rocks of the southern Urals (to which M. L. Duparc brings his experience); and the classification of felspar twins, by M. R. Sabot. It is clear that geologists must keep even the minor publications of this society within their scope.

CAPTAINS and officers of vessels traversing the North Atlantic will find much of value and interest to them in the series of "Monthly Meteorological Charts" issued by the Meteorological Office. The chart for September gives the distribution of winds and ocean currents at this season of the year, and the mean values of the barometer are indicated by isobars over the sea as well as over the adjacent land. Mean temperatures of air and sea surface are also given. The normal conditions show a large area of high barometer readings centred in mid-Atlantic, around which there is a general circulation of winds. A smaller region of high barometer embraces New York and the neighbouring land and sea. Areas of low barometer occur to the south of Greenland and near the equator, as well as over North America and Central Africa, all of which materially influence the normal wind circulation. The extension of the "Gulf Stream" is very evident on the eastern side of the Atlantic to as far as 50° or 55° N. latitude. The southern limit of the north-east trade, and the northern limit of the south-east trade, winds embrace an area centred in about 10° N. latitude. On the reverse of the chart a brief description is given of the different types of atmospheric systems which produce certain and distinct kinds of weather, and illustrations are given which will be helpful to the navigator in constructing a weather chart for himself with the aid of wireless reports he may receive.

THE *Meteorological Magazine* for August shows that every effort is being made to improve the Daily Weather Report. Sea- and air-temperatures and the weather in home waters are now incorporated, whilst since August 1 a small map is given showing "barometric tendency" for the three hours from 4h. to 7h. For the special advantage of aeronauts a method of obtaining the degree of visibility on cloudy nights is suggested by Capt. W. H. Pick. The use of the grease-spot photometer of Bunsen is advocated, calibrated in accordance with the visibility-scale adopted by the Meteorological Office and allied authorities. The apparatus consists of a drop or two of molten grease on a sheet of writing paper and a candle placed behind the grease spot. The observer faces the spot and moves backward, noticing the exact position at which the spot of grease becomes indistinguishable on the paper. The distance of indistinguishability in feet is given in a tabular form for the respective units of the visibility-scale. Careful examination of the suggestion by independent workers is desirable before its final adoption. At best it seems that the method must be rough. July is stated to have been generally a wet month over the British Isles, and the Thames Valley rainfall map shows some areas having a fall of more than 6 in. The general July rainfall for England and Wales was 161 per cent. of the average, Scotland 104 per cent., and Ireland 153 per cent.

IT has long been known that the sensitiveness of photographic bathed plates can be increased by the addition of ammonia to the dye-bath, though at the expense of keeping qualities and freedom from chemical fog. Mr. S. M. Burka has critically studied, at the American Bureau of Standards, the action of ammonia on commercial plates, hoping thereby to increase their sensitiveness and facilitate aerial photography. His communication to the Franklin Institute on the subject is reproduced in the *British Journal of Photography* for August 6, 13, and 20. He finds that ordinary and orthochromatic plates are not much, if at all, affected by bathing them in weak ammonia, but panchromatic plates may be increased in sensitiveness to as much as five times. More usually the increase is to about twice, but even then the sensitiveness to red may be increased to five times and be extended 100 or more Ångström units. Plates which show irregular curves of spectrum sensitiveness have their minima raised, and in many cases smoothed out entirely. It is preferred to add alcohol to the ammonia bath, because without it the plates must be used as soon as they are dry, although if it is omitted the sensitiveness is increased to a still greater extent. The communication is illustrated by numerous spectrum and other curves and diagrams, and some aerial photographs in which a comparison can be made between the effect of using the treated and the untreated plates.

PROF. LUIGI PALAZZO, director of the Meteorological Office at Rome, has sent us a separate copy of his discussion in the *Annali del R. Ufficio Centrale di Meteorologia e Geodinamica* (vol. xxxvii., part 1) of comparisons made of magnetic instruments at Terracina in 1901, 1911, and 1913. On the first occasion the instruments of the Meteorological Office at Rome were compared with those used in the Polar expedition of the Duke of the Abruzzi. On the other occasions the comparison was between the Roman instruments and others belonging to the Carnegie Institution of Washington. Prof. Palazzo himself observed with the Roman instruments. The American observers were Mr. W. H. Sligh in 1911 and Mr. W. F. Wallis in 1913. Terracina was selected as being free from the artificial disturbances which for some time have rendered Rome unsuitable as a magnetic station. It is interesting to note that all the dip-circles used were of English construction. The magnetometers were of different patterns. The comparisons with the Washington instruments are of most general interest. In the case of declination the mean difference between the Rome and Washington instruments was only 0·2′ in 1911 and 0·1′ in 1913—differences which are probably too small to rely on. In both years the Washington instruments gave the smaller dip and the larger value for the horizontal force. But the apparent differences between them and the Roman instruments were substantially different on the two occasions. Consistency to 0·1′ in dip and to 1γ in horizontal force is probably too much to expect from ordinary dip-circles and unifilar magnetometers.

THE University Tutorial Press, Ltd., announces that it has in preparation a new series of text-books for use in agricultural schools and colleges. The first book of this series, which it is hoped will be issued next month, is "The Chemistry of Crop Production," by Prof. T. B. Wood, head of the Cambridge University School of Agriculture. This will be followed later by "Animal Food Production" by the same author. A volume on "Chemistry for Agricultural Students," by Mr. R. H. Adie, is also in active preparation.

WE learn from Mr. Wilson L. Fox that the statement made in NATURE for August 26 (p. 837) with reference to the rainfall at Falmouth for August 18 is incorrect. The Daily Weather Report gives the rainfall as 6 mm. between 7 a.m. and 6 p.m., and not 2·21 in. between 8 a.m. and 7 p.m., as was reported.

Our Astronomical Column.

THE NEW STAR IN CYGNUS.—Mr. Denning writes that this nova declined in brightness very quickly after its maximum on August 24, but at the end of that month maintained its light for a few days, so that its magnitude remained at about 4·2, and the nova was a little brighter than the star 33 Cygni. The magnitude on August 24 was 1·8. Since that date the estimated magnitudes at Bristol have been:

August	25 ... 2·7		September	1 ... 4·1
	26 ... 2·9			2 ... 4·2
	28 ... 3·5			3 ... 4·5
	29 ... 3·9			4 ... 4·7
	31 ... 4·2			

RADIATION PRESSURE NEAR THE SUN.—Radiation pressure has been freely invoked in recent years to explain various celestial phenomena. Prof. Eddington, who was one of the first to suggest that it may play a very important part in the interior of the giant stars, contributes a note to Mon. Not. R.A.S. for June, in which he examines the maximum effects that it could produce outside the sun. Assuming a temperature of 10,000° C. at the surface of the photosphere (which is purposely taken considerably in excess of the most probable value), then the radiation just outside the photosphere is equivalent to a wind-pressure of 30 dynes per sq. cm., which could not support a greater mass than 1 milligram against the solar gravitation. Thus if a prominence 10,000 km. deep were upheld by radiation, its mass could not exceed a milligram per sq. cm. of its base, implying a density of 10^{-12}, which is difficult to accept, in view of the fact that the prominences are visible in spectrograms as dark markings on the solar disc. Prof. Eddington estimates the maximum density of the corona and the tails of comets (on the radiation theory) as 10^{-18}. These are less difficult to accept, as it is known on other grounds that their density is extremely small.

DISTRIBUTION OF INTENSITY IN SOLAR AND STELLAR SPECTRA.—Mr. Bertil Lindblad, of Upsala Observatory, has made an important study of effective and minimum wave-lengths in grating spectra of the sun and stars (Upps. Univ. Årsskrift, 1920, Mat. och Naturvetenskap 1). He claims that the method affords an independent determination of absolute magnitude without making use of the spectral lines, being thus a check of the method of Adams and Joy. In particular, stars are giants the effective wave-length of which exceeds 426 $\mu\mu$. The effective temperature of the solar photosphere is found to diminish from 6200° at the middle of the disc to 5430° at the limb. The difference is ascribed to the lower depth from which we receive light in the former case. Detailed measures of the spectra of sixty stars of known spectral type and luminosity are then given, and curves drawn connecting minimum wave-length with absolute magnitude for the various spectral types.

A detailed examination of a special region in Cepheus is then given, in which the data previously acquired are utilised. It contains the extreme dwarf Krüger 60; two other stars are found to be dwarfs, B.D. 57° 2514 and 56° 2779. Their spectral parallaxes are given as 0·03″ and 0·04″, and an annual P.M. of 0·5″ is suspected in each case from comparison with the B.D. places.

On the other hand, there are several red giants in the region, the distance of which is given as 4700 light-years; this is suggested as the distance of the galactic star-cloud which occupies the region.

Scientific Studies of Non-ferrous Alloys.*

By C. T. HEYCOCK, M.A., F.R.S.

THE production of metals and their alloys undoubtedly constitutes the oldest of those chemical arts which ultimately expanded into the modern science of chemistry, with all its overwhelming mass of experimental detail and its intricate interweaving of theoretical interpretation of the observed facts. Tubal-cain lived during the lifetime of our common ancestor, and was "an instructor of every artificer in brass and iron"; and although it may be doubted whether the philologists have yet satisfactorily determined whether Tubal-cain was really acquainted with the manufacture of such a complex metallic alloy as brass, it is certain that chemical science had its beginnings in the reduction of metals from their ores and in the preparation of useful alloys from those metals. In fact, metallic alloys, or mixtures of metals, have been used by mankind for the manufacture of implements of war and of agriculture, of coinage, statuary, cooking vessels, and the like from the very earliest times.

In the course of past ages an immense amount of practical information has been accumulated concerning methods of reducing metals, or mixtures of metals, from their ores, and by subsequent treatment, usually by heating and cooling, of adapting the resulting metallic product to the purpose for which it was required. Until quite recent times, however, the whole of this knowledge was entirely empirical in character, because it had no foundation in general theoretical principles; it was collected in haphazard fashion in accordance with that method of trial and error which led our forerunners surely, but with excessive expenditure of time and effort, to valuable results.

To-day I purpose dealing chiefly with the non-ferrous alloys, not because any essential difference in type exists between the ferrous and non-ferrous alloys, but merely because the whole field presented by the chemistry of the metals and their alloys is too vast to be covered in any reasonable length of time.

The earliest recorded scientific investigations on alloys were made in 1722 by Réaumur, who employed the microscope to examine the fractured surfaces of white and grey cast-iron and steel. In 1808 Widmanstätten cut sections from meteorites, which he polished and etched. The founder, however, of modern metallography is undoubtedly H. C. Sorby, of Sheffield. Sorby's early petrographic work on the examination of thin sections of rock under the microscope led him to a study of meteorites and of iron and steel, and in a paper read before the British Association in 1864 he describes briefly (I quote his own words) how sections "of iron and steel may be prepared for the microscope so as to exhibit their structure to a perfection that leaves little to be desired. They show various mixtures of iron, and two or three well-defined compounds of iron and carbon, graphite, and slag; these constituents, being present in different proportions and arranged in various manners, give rise to a large number of varieties of iron and steel, differing by well-marked and very striking peculiarities of structure." The methods described by Sorby for polishing and etching alloys and his method of vertical illumination (afterwards improved by Beck) are employed to-day by all who work at this branch of metallography.

From 1854–68 Mattheisen published in the Reports of the British Association and in the Proceedings and Transactions of the Royal Society a large number of papers on the electrical conductivity, tenacity, and specific gravity of pure metals and alloys. He concluded that alloys are either mixtures of definite chemical compounds with an excess of one or other metal, or solutions of the definite alloy in the excess of one of the metals employed, forming in their solid condition what he called a solidified solution. This idea of a solidified solution has developed into a most fruitful theory upon which much of our modern notions of alloys depends. Although, at the time, the experiments on the electrical conductivity did not lead to very definite conclusions, the method has since been used with great success in testing for the presence of minute quantities of impurities in the copper used for conductors. In the *Philosophical Magazine* for 1875 F. Guthrie, in a remarkable paper quite unconnected with alloys, gave an account of his experiments on salt solutions and attached water. He was led to undertake this work by a consideration of a paper by Dr. J. Rea, the Arctic explorer, on the comparative saltness of freshly formed and of older ice-floes. Guthrie showed that the freezing point of solutions was continuously diminished as the percentage of common salt increased, and that this lowering increased up to 23·6 per cent. of salt, when the solution solidified as a whole at about 22° C. He further showed, and this is of great importance, that the substance which first separated from solutions more dilute than 23·6 per cent. was pure ice. To the substance which froze as a whole, giving crystals of the same composition as the mother-liquor, he gave the name "cryohydrate."

In the *Philosophical Magazine* for 1876 Guthrie gave an account of his experiments, using solvents other than water, and states that the substances which separate at the lowest temperature are neither atomic nor molecular; this lowest melting-point mixture of two bodies he names the eutectic mixture. In the same paper he details the methods of obtaining various eutectic alloys of bismuth, lead, tin, and cadmium.

We have in these papers of Guthrie's the first important clue to what occurs on cooling a fused mixture of metals. The researches of Sorby and Guthrie, undertaken as they were for the sake of investigating natural phenomena, are a remarkable example of how purely scientific experiment can lead to most important practical results. It is not too much to claim for these investigators the honour of being the originators of all our modern ideas of metallurgy. Although much valuable information had been accumulated, no rapid advance could be made until some general theory of solution had been developed. In 1878 Raoult first began his work on the depression of the freezing point of solvents due to the addition of dissolved substances, and he continued at frequent intervals to publish the results of his experiments up to the time of his death in 1901.

In a paper in the *Zeit. Physikal. Chem.* for 1888 on "Osmotic Pressure in the Analogy between Solutions and Gases," van't Hoff showed that the experiments of Pfeffer on osmotic pressure could be explained on the theory that dissolved substances were, at any rate for dilute solutions, in a condition similar to that of a gas; that they obeyed the laws of Boyle, Charles, and Avogadro; and that on this assumption the depression of the freezing point of a solvent could be calculated by means of a simple formula. He also showed that the exceptions which occurred to Raoult's

* From the opening address of the President of Section B (Chemistry) delivered at the Cardiff meeting of the British Association on August 24.

laws, when applied to aqueous solutions of electrolytes, could be explained by the assumption, first made by Arrhenius, that these latter in solution are partly dissociated into their ions. The result of all this work was to establish a general theory applicable to all solutions which has been widespread in its applications. From this time the study of alloys began to make rapid progress.

The experiments of Laurie, Tannman, and Neville and myself in 1888 and 1889 helped to establish the similarity between the behaviour of metallic solutions or alloys and that of aqueous and other solutions of organic compounds in organic solvents. That our experiments were correct seemed probable from the agreement between the observed depression of the freezing point and the value calculated from van't Hoff's formula for the case of those few metals the latent heats of fusion of which had been determined with any approach to accuracy.

Our experiments, afterwards extended to other solvents, led to the conclusion that in the case of most metals dissolved in tin the molecular weight is identical with the atomic weight; in other words, that the metals in solution are monatomic. This conclusion, however, involves certain assumptions. Sir William Ramsay's experiments on the lowering of the vapour pressure of certain amalgams point to a similar conclusion.

So far our work had been carried out with mercury thermometers, standardised against a platinum resistance pyrometer, but it was evident that, if it was to be continued, we must have some method of extending our experiments to alloys which freeze at high temperatures. The thermo-couple was not at this stage a trustworthy instrument; fortunately, however, Callendar and Griffiths had brought to great perfection the electrical resistance pyrometer (Phil. Trans., A, 1887 and 1891). Dr. E. H. Griffiths kindly came to our aid, and with his help we installed a complete electrical resistance set. As at this time the freezing points of pure substances above 300° were not known with any degree of accuracy, we began by making these measurements:—

Table of Freezing Points.

—	Carnelly's Tables	Holborn and Wien, 1892	Callendar and Griffiths, 1892	Neville and Heycock, 1895	Burgess and Le Chatelier, 1912. High Temperature Measurements
Tin ...	—	—	231·7	231·9	231·9
Zinc ...	433	—	417·6	419·0	419·4
Lead ...	—	—	—	327·6	327·4
Antimony...	432	—	—	629·5	630·7 & 629·2
Magnesium	—	—	—	632·6[1]	650
Aluminium	700	—	—	654·5[2]	658
Silver ...	954	968	972	960·7	960·9
Gold ...	1045	1072	1037	1061·7	1062·4
Copper ...	1054	1082	—	1080·5	1083
Sulphur B.P.	448	—	444·53	—	444·7

[1] Contaminated with silicon. [2] Known to be impure.

With the exception of silver and gold, these metals were the purest obtainable in commerce.

During the period that the above work on non-ferrous alloys was being done, great progress was being made in the study of iron and steel by Osmond and Le Chatelier. In 1890 the Institution of Mechanical Engineers formed an Alloys Research Committee. This committee invited Prof. (afterwards Sir William) Roberts-Austen to undertake research work for it. The results of his investigations are contained in a series of five valuable reports extending from 1891 to 1899, published in the Journal of the institution. The fifth is of especial importance, because, besides a description of the thermal effects produced by carbon, which he carefully plotted and photographed, he described the microscopical appearance of the various constituents of iron. The materials of this report, together with the work of Osmond and others on steel and iron, provided much of the material on which Prof. Bakhuis Roozeboom founded the iron-carbon equilibrium diagram. Reference should also be made to the very valuable paper by Stansfield on the present position of the solution theory of carbonised iron (Journ. Iron and Steel Inst., vol. xi., 1900, p. 317). It may be said of this fifth report, and of the two papers just referred to, that they form the most important contribution to the study of iron and steel that has ever been published. Although the diagram for the equilibrium of iron and carbon does not represent the whole of the facts, it affords the most important clue to these alloys, and undoubtedly forms the basis of most of the modern practice of steel manufacture. Many workers, both at home and abroad, were now actively engaged in metallurgical work—Stead, Osmond, Le Chatelier, Arnold, Hadfield, Carpenter, Ewing, Rosenhain, and others too numerous to mention.

In 1897 Neville and I determined the complete freezing-point curve of the copper-tin alloys, confirming and extending the work of Roberts-Austen, Stansfield, and Le Chatelier; but the real meaning of the curve remained as much of a mystery as ever. Early in 1900 Sir G. Stokes suggested to us that we should make a microscopic examination of a few bronzes as an aid to the interpretation of the singularities of the freezing-point curve. An account of this work, which occupied us for more than two years, was published as the Bakerian lecture of the Royal Society in February, 1903. Whilst preparing a number of copper-tin alloys of known composition we were struck by the fact that the crystalline pattern which developed on the free surface of the slowly cooled alloys was entirely unlike the structure developed by polishing and etching sections cut from the interior; it therefore appeared probable that changes were going on within the alloys as they cooled. In the hope that, as Sorby had shown in the case of steel, we could stereotype or fix the change by sudden cooling, we melted small ingots of the copper-tin alloys and slowly cooled them to selected temperatures and then suddenly chilled them in water. The results of this treatment were communicated to the Royal Society and published in the Proceedings of February, 1901.

To apply this method to a selected alloy we first determined its cooling curve by means of an automatic recorder, the curve usually showing several halts or steps in it. The temperature of the highest of these steps corresponded with a point on the liquidus, *i.e.* when solid first separated out from the molten mass. To ascertain what occurred at the later halts, ingots of the melted alloy were slowly cooled to within a few degrees above and below the halt and then chilled.

The method of chilling also enabled us to fix, with some degree of accuracy, the position of points on the solidus. If an alloy, chilled when it is partly solid and partly liquid, is polished and etched, it will be seen to consist of large primary combs embedded in a matrix consisting of mother-liquor, in which are disseminated numerous small combs, which we called "chilled primary." By repeating the process at successively lower and lower temperatures we obtained a point at which the chilled primary no longer formed, *i.e.* the upper limit of the solidus.

Although we made but few determinations of the physical properties of the alloys, it is needless to say how much they vary with the temperature and with the rapidity with which they are heated or cooled.

From a consideration of the singularities in the liquidus curve, coupled with the microscopic examination of slowly cooled and chilled alloys, we were able to divide the copper-tin alloys into certain groups having special qualities.

So far I have directed attention to some of the difficulties encountered in the examination of binary alloys. When we come to ternary alloys the difficulties of carrying out an investigation are enormously increased, whilst with quaternary alloys they seem almost insurmountable; in the case of steels containing always six, and usually more, constituents we can hope at present to get information only by purely empirical methods. Large numbers of the elements and their compounds, which originally were laboriously prepared and investigated in the laboratory and remained dormant as chemical curiosities for many years, have, in the fullness of time, taken their places as important, and indeed essential, articles of commerce. I may remark that even during my own lifetime I have seen a vast number of substances transferred from the category of rare laboratory products to that which comprises materials of the utmost importance to the modern metallurgical industries. A few decades ago aluminium, chromium, cerium, thorium, tungsten, manganese, magnesium, molybdenum, nickel, calcium and calcium carbide, carborundum, and acetylene were unknown outside the chemical laboratory of the purely scientific investigator; to-day, these elements, their compounds and alloys, are amongst the most valuable of our industrial metallic products. They are essential in the manufacture of high-speed steels, of armour-plate, of filaments for the electric bulb lamp, of incandescent gas mantles, and of countless other products of modern scientific industry. All these metallic elements and compounds were discovered, and their industrial uses foreshadowed, during the course of the purely academic research work carried out in our universities and colleges; all have become the materials upon which great and lucrative industries have been built up. Although the scientific worker has certainly not exhibited any cupidity in the past, and has been content to rejoice in his own contributions to knowledge and to see great manufacturing enterprises founded upon his work, it is clear that the obligation devolves upon those who have reaped in the world's markets the fruit of scientific discovery to provide from their harvest the financial aid without which scientific research cannot be continued.

The truth of this statement is well understood by those of our great industrial leaders who are engaged in translating the results of scientific research into technical practice. As evidence of this I may quote the magnificent donation of 210,000*l*. by the British oil companies towards the endowment of the school of chemistry in the University of Cambridge; the noble bequest of the late Dr. Messel, one of the most enlightened of our technical chemists, for defraying the cost of scientific research; the gifts of the late Dr. Ludwig Mond towards the upkeep and expansion of the Royal Institution, one of the strongholds of British chemical research; and the financial support given by the Goldsmiths' and others of the great City of London Livery Companies (initiated largely by the late Sir Frederick Abel, Sir Frederick Bramwell, and Mr. George Matthey) to the foundation of the Imperial College of Science and Technology. The men who initiated these gifts have been themselves intimately associated with developments in both science and industry; they have understood that the field must be prepared before the crop can be reaped. Fortunately, our great chemical industries are, for the most part, controlled and administered by men fully conversant with the mode in which technical progress and prosperity follow upon scientific achievement; and it is my pleasant duty to record that within the last few weeks the directors of one of our greatest chemical manufacturing concerns have, with the consent of their shareholders, devoted 100,000*l*. to research. Doubtless other chemical industries will in due course realise what they have to gain by an adequate appreciation of pure science. If the effort now being made to establish a comprehensive scheme for the resuscitation of chemical industry within our Empire is to succeed, financial support on a very liberal scale must be forthcoming from the industry itself for the advancement of purely scientific research. This question has been treated recently in so able a fashion by Lord Moulton that nothing now remains but to await the results of his appeal for funds in aid of the advancement of pure science.

In order to prevent disappointment and a possible reaction in the future in those who endow pure research, it is necessary to give a word of warning. It must be remembered that the history of science abounds in illustrations of discoveries, regarded at the time as trivial, which have in after-years become epoch-making. In illustration I would cite Faraday's discovery of electro-magnetic induction. He found that when a bar-magnet was thrust into the core of a bobbin of insulated copper wire, the terminals of which were connected with a galvanometer, a momentary current was produced; while on withdrawing the magnet a momentary reverse current occurred—a purely scientific experiment destined in later years to develop into the dynamo and with it the whole electrical industry. Another illustration may be given: Guyton de Morveau, Northmore, Davy, Faraday, and Cagniard Latour between 1800 and 1850 were engaged in liquefying many of the gases. Hydrogen, oxygen, nitrogen, marsh gas, carbon monoxide, and nitric oxide, however, resisted all efforts until the work of Joule and Andrews gave the clue to the causes of failure. Some thirty years later, by careful application of the theoretical considerations, all the gases were liquefied. The liquefaction of oxygen and nitrogen now forms the basis of a very large and important industry.

Such cases can be multiplied indefinitely in all branches of science.

Perhaps the most pressing need of the present day lies in the cultivation of a better understanding between our great masters of productive industry, the shareholders to whom they are in the first degree responsible, and our scientific workers; if, by reason of any turbidity of vision, our large manufacturing corporations fail to discern that, in their own interest, the financial support of purely scientific research should be one of their first cares, technical advance will slacken, and other nations adopting a more far-sighted policy will forge ahead in science and technology. It should, I venture to think, be the bounden duty of everyone who has at heart the aims and objects of the British Association to preach the doctrine that in closer sympathy between all classes of productive labour, manual and intellectual, lies our only hope for the future. I cannot do better than conclude by quoting the words of Pope, one of our most characteristically British poets:

> By mutual confidence and mutual aid
> Great deeds are done and great discoveries made.

Economic and Educational Aspects of Zoology.*

By Prof. J. Stanley Gardiner, M.A., F.R.S.

Great as have been the results in physical sciences applied to industry, the study of animal life can claim discoveries just as great. Their greatest value, however, lies, not in the production of wealth, but rather in their broad applicability to human life. Man is an animal, and he is subject to the same laws as are other animals. He learns by the experience of his forbears, but he learns also by the consideration of other animals in relationship to their fellows and to the world at large. The whole idea of evolution, for instance, is of indescribable value; it permeates all life to-day; and yet Charles Darwin, whose researches did more than any others to establish its facts, is too often known to the public only as "the man who said we came from monkeys."

Whilst, first and foremost, I would base my claim for the study of animal life on this consideration, we cannot neglect the help it has given to the physical welfare of man's body. It is not out of place to direct attention to the manner in which pure zoological science has worked hand-in-hand with the science of medicine. Harvey's experimental discovery of the circulation of the blood laid the foundation for that real knowledge of the working of the human body which is at the basis of medicine; our experience of the history of its development gives us good grounds to hope that the work that is now being carried out by numerous researchers under the term "experimental" will ultimately elevate the art of diagnosis into an exact science. Harvey's work, too, mostly on developing chicks, was the starting-point for our knowledge of human development and growth. Instances in medicine could be multiplied wherein clinical treatment has been rendered possible only by laborious research into the life-histories of certain parasites preying often on man and other animals alternately. In this connection there seems reason at present for the belief that the great problem of medical science, cancer, will reach its solution from the zoological side. A pure zoologist has shown that typical cancer of the stomach of the rat can be produced by a parasitic threadworm (allied to that found in pork, Trichina), this having as a carrying host the American cockroach, brought over to the large warehouses of Copenhagen in sacks of sugar. Our attack on such parasites is made effective only by what we know of them in lower forms, which we can deal with at will. Millions of the best of our race owe their lives to the labours of forgotten men of science who laid the foundations of our knowledge of the generations of insects and flat-worms, the modes of life of lice and ticks, the physiology of such lowly creatures as Amœba and Paramecium, and of parasitic disease—malaria, Bilharziasis, typhus, trench fever, and dysentery.

Of immense economic importance in the whole domain of domestic animals and plants was the rediscovery early in the present century of the completely forgotten work of Gregor Mendel on cross-breeding, made known to the present generation largely by the labours of a former president of this Association, who, like a true man of science, claims no credit for himself. We see results already in the few years that have elapsed in special breeds of wheat, in which have been combined with exactitude the qualities man desires. The results are in the making—and this is true of all things in biology—but can anyone doubt that the breeding of animals is becoming an exact science? We have got far, perhaps, but we want to get much further in our understanding of the laws governing human heredity; we have to establish immunity to disease. Without the purely scientific study of chromosomes (the bodies which carry the physical and mental characteristics of parents to children) we could have got nowhere, and to reach our goal we must know more of the various forces which in combination make up what we term life.

In agricultural sciences we are confronted with pests in half a dozen different groups of animals. We have often to discover which of two or more is the damaging form, and the difficulty is greater where the damage is due to association between plant and animal pests. Insects are, perhaps, the worst offenders, and our basal knowledge of them as living organisms—they can do no damage when dead, and perhaps pinned in our showcases—is due to Redi, Swammerdam, and to Réaumur in the middle of the eighteenth century. Our present successful honey production is founded on the curiosity of these men in respect to the origin of life and the generation of insects. The fact that most of the dominant insects have a worm (caterpillar or maggot) stage of growth, often of far longer duration than that of the insects, has made systematic descriptive work on the relation of worm and insect of peculiar importance. I hesitate, however, to refer to catalogues in which perhaps a million different forms of adults and young are described. Nowadays we know, to a large degree, with what pests we deal, and we are seeking remedies. We fumigate and we spray, spending millions of money, but the next remedy is in the use of free-living enemies or parasitics to prey on the insect pests. The close correlation of anatomy with function is of use here in that life-histories, whether parasitic, carnivorous, vegetarian, or saprophagous, can be foretold in fly-maggots from the structure of the front part of their gut (pharynx); we know whether any maggot is a pest, harmless, or beneficial.

I will not disappoint those who expect me to refer more deeply to science in respect to fisheries, but its operations in this field are less known to the public at large. The opening up of our north-western grounds and banks is due to the scientific curiosity of Wyville Thomson and his *confrères* as to the existence or non-existence of animal life in the deep sea. It was sheer desire for knowledge that attracted a host of inquirers to investigate the life-history of river-eels. The wonder of a fish living in our shallowest pools and travelling two or three thousand miles to breed, very likely on the bottom in 2000 fathoms, and subjected to pressures varying from 14 lb. to 2 tons per square inch, is peculiarly attractive. It shows its results in regular eel-farming, the catching and transplantation of the baby eels out of the Severn into suitable waters which cannot, by the efforts of Nature alone, be sure of their regular supply. Purely scientific observations on the life-histories of flat-fish—these were largely stimulated by the scientific curiosity induced by the views of Lamarck and Darwin as to the causes underlying their anatomical development—and on the feeding value and nature of Thisted Bredning and the Dogger Bank, led to the successful experiments on transplantation of young

* From the opening address of the President of Section D (Zoology) delivered at the Cardiff meeting of the British Association on August 24.

plaice to these grounds and the remarkable growth-results obtained, particularly on the latter. Who can doubt that this "movement of herds" is one of the first results to be applied in the farming of the North Sea so soon as the conservation of our fish supply becomes a question of necessity?

The abundance of mackerel is connected with the movements of Atlantic water into the English Channel and the North Sea—movements depending on complex astronomical, chemical, and physical conditions. They are further related to the food of the mackerel, smaller animal life which dwells only in these Atlantic waters. These depend, as indeed do all animals, on that living matter which possesses chlorophyll for its nutrition, and which we call plant. In this case the plants are spores of algæ, diatoms, etc., and their abundance as food again depends on the amount of the light of the sun—the ultimate source, it might seem, of all life.

A method of ascertaining the age of fishes was sought purely to correlate age with growth in comparison with the growth of air-living vertebrates. This method was found in the rings of growth in the scales, and now the ascertaining of age-groups in herring shoals enables the Norwegian fishermen to know with certainty what possibilities and probabilities are before them in the forthcoming season. From the work on the blending together of Atlantic with Baltic and North Sea water off the Baltic Bight and of the later movements of this "bankwater," as it is termed, into the Swedish fjords can be understood, year by year, the Swedish herring fishery. It is interesting that these fisheries have been further correlated with cycles of sun-spots, and also with longer cycles of lunar changes.

The mass of seemingly unproductive scientific inquiries undertaken by the United States Bureau of Fisheries thirty to fifty years ago was the forerunner of their immense fish-hatching operations, whereby billions of fish-eggs are stripped year by year and the fresh waters of that country made into an important source for the supply of food. The study of the growth-stages of lobsters and crabs has resulted in sane regulations to protect the egg-carrying females, and in some keeping up of the supply in spite of the enormously increased demand. Lastly, the study of free-swimming larval stages in Mollusca, stimulated immensely by their similarity to larval stages in worms and starfishes, has given rise to the establishment of a successful pearl-shell farm at Dongonab, in the Red Sea, and of numerous fresh-water mussel fisheries in the southern rivers of the United States, to supply small shirt-buttons.

Fishery investigation was not originally directed to a more ambitious end than giving a reasonable answer to a question of the wisdom or unwisdom of compulsorily restricting commercial fishing, but it was soon found that this answer could not be obtained without the aid of pure zoology. The spread of trawling—and particularly the introduction of steam trawling during the last century—gave rise to grave fears that the stock of fish in home waters might be very seriously depleted by the use of new methods. We first required to know the life-histories of the various trawled fish, and Sars and others told us that the eggs of the vast majority of the European marine food species were pelagic—in other words, that they floated, and thus could not be destroyed, as had been alleged. Trawl-fishing might have to be regulated all the same, for there might be an insufficient number of parents to keep up the stock. It was clearly necessary to know the habits, movements, and distribution of the fishes, for all were not throughout their life or at all seasons found on the grounds it was practicable to fish.

But why multiply instances of the applications of zoology as a pure science to human affairs? Great results are asked for on every side of human activities. The zoologist, if he be given a chance to live and to hand on his knowledge and experience to a generation of pupils, can answer many of them. He is increasingly getting done with the collection of anatomical facts, and turning more and more to the why and how animals live. We may not know in our generation or in many generations what life is, but we can know enough to control that life. The consideration of the fact that living matter and water are universally associated opens up high possibilities. The experimental reproduction of animals, without the interposition of the male, is immensely interesting; where it will lead no one can foretell. The association of growth with the acidity and alkalinity of the water is a matter of immediate practical importance, especially to fisheries. The probability of dissolved food-material in sea- and river-water, independent of organised organic life and absorbable over the whole surfaces of animals, is clearly before us. Is it possible that that dissolved material may be even now being created in Nature without the assistance of organic life? The knowledge of the existence in food of vitamines, making digestible and usable what in food would otherwise be wasted, may well result in economies of food that will for generations prevent the necessity for the artificial restriction of populations. The parallel between these vitamines and something in sea-water may quite soon apply practically to the consideration of all life in the sea. Finally, what we know of the living matter of germ-cells puts before us the not impossible hope that we may influence for the better the generations yet to come.

So far I have devoted my attention primarily, in this survey of the position of zoology, to the usefulness of the subject. Let us now note where we stand in respect to other subjects and in meeting the real need for wide zoological study.

Let me give a few facts which have their sweet and bitter for us who make zoology our life-work. During the war we wanted men who had passed the honours schools in zoology—and hence were presumably capable of doing the work—to train for the diagnosis of protozoal disease. We asked for all names from 1905 to 1914 inclusive, and the average worked out at under fourteen per year from all English universities: an average of one student per university per year. In the year 1913–14 every student who had done his honours course in zoology in 1913 could, if he had taken entomology as his subject, have been absorbed into the economic applications of that subject. Trained men were wanted to undertake scientific fishery investigations, and they could not be found. Posts were advertised in animal breeding, in helminthology, and in protozoology, three other economic sides of the subject. The Natural History Museum wanted systematists, and there were many advertisements for teachers. How many of these posts were filled I do not know, but it is clear that not more than one-half—or even one-third—can have been filled efficiently. Can any zoologist say that all is well with his subject in the face of these deficiencies?

The demands for men in the economic sides of zoology are continually growing, and it is the business of universities to try to meet these demands. There are Departments of Government at home and in our Colonies which, in the interests of the people they govern, wish to put into operation protective measures, but cannot do so because there are not the men with the requisite knowledge and common sense required for inspectorates. There are others that wish for research to develop so as to conserve existing industries as well as to discover new ones, and they, too, are compelled to mark time.

In default, or in spite, of the efforts of the schools of pure zoology, attempts are being made to set up special training schools in fisheries, in entomology, and in other economic applications of zoology. Each branch is regarded as a science, and the supporters of each suppose they can, from the commencement of a lad's scientific training, give specialised instruction in each. The researcher in each has to do the research which the economic side requires. But he cannot restrict his education to one science; he requires to know the principles of all sciences; he must attempt to understand what life is. Moreover, his specialist knowledge can seldom be in one science. The economic entomologist, however deep his knowledge of insects may be, will find himself frequently at fault in distinguishing cause and effect unless he has some knowledge of mycology. The protozoologist must have an intimate knowledge of unicellular plants, bacterial and other. The animal-breeder must know the work on cross-fertilisation of plants. The fisheries man requires to understand physical oceanography. The helminthologist and the veterinary surgeon require an intimate knowledge of a rather specialised "physiology." All need knowledge of the comparative physiology of animals in other groups beyond those with which they deal, to assist them in their deductions and to aid them to secure the widest outlook. It is surely a mistake, while the greatest scientific minds of the day find that they require the widest knowledge, to endeavour to get great scientific results out of students whose training has been narrow and specialised. Such specialisation requires to come later, and can replace nothing. This short cut is the longest way round. The danger is not only in our science, but in every science.

Surely the time has now come for us to lift our eyes from our tables of groups and families, and, on the foundations of the knowledge of these, to work on the processes going on in the living body, the adaptation to environment, the problems of heredity, and at many another fascinating hunt in unknown country. Let us teach our students not only what is known, but, still more, what is unknown, for in the pursuit of the latter we shall engage eager spirits who care naught for collections of corpses. My own conviction is that we are in danger of burying our live subject along with our specimens in museums.

As a result of the wrong teaching of zoology, we see proposals to make so-called "Nature-study" in our schools purely botanical. Is this proposal made in the interests of the teacher or of the children? It surely cannot be for "decency" if the teaching is honest, for the phenomena are the same, and there is nothing "indecent" common to all life. "The proper study of mankind is man," and the poor child, athirst for information about himself, is given a piece of moss or duckweed, or even a chaste buttercup. Is the child supposed to get some knowledge it can apply economically? Whatever the underlying ideas may be, this course will not best develop the mind to enable it to grapple with all phenomena, the aim of education. If necessary, the school teacher must go to school; he must bring himself up to date in his own time, as every teacher in science has to do; it is the business of universities to help him, for nothing is more important to all science than the foundations of knowledge.

Native Races of the Empire.

AMONG the resolutions adopted by the General Committee of the British Association during the recent meeting at Cardiff, several dealt with problems connected with the native races of the Empire. Of these one referred to the deplorable conditions now prevailing among the aboriginal tribes of Central Australia, of which an account was recently given in these columns (see NATURE, July 8, p. 601). The Association urged upon the Federal Government and the Governments of Western Australia and South Australia the desirability of establishing an absolute reservation upon part of the lands now occupied by the tribes within the jurisdiction of these Governments in order that they might be preserved from extinction. The resolution further emphasised the necessity of establishing a medical service for the natives in order to check the ravages of disease by which they are now rapidly being reduced in numbers. It may be hoped that the influence of the Association will add force to the movement which has already been set on foot in South Australia, and induce the Governments concerned to take action in this matter.

A second resolution of the Association dealt with the desirability of initiating an anthropological survey of the natives of Western Australia. In this State the natives are under the control of Protectors of Aborigines, and are, for the most part, either located on Government farms or stations, or, if employed by private owners, the conditions of their employment are strictly regulated by the Protectors. Notwithstanding the measures taken for their well-being and preservation, which include a medical service and an organised system of food-supply for times of scarcity, they are dwindling in numbers. At the same time, in the changed conditions, the memory of their tribal customs and traditions is being lost. In the interests of science it is, therefore, highly desirable that some record should be made of their language, customs, traditions, and beliefs, as well as of their physical characters, before the older members of the tribes die out.

During the past summer, it will be remembered, Gen. Smuts introduced into the South African Parliament a Bill dealing with the native population. This Bill has been described as embodying the most important proposals in reference to the native problem since the Glen Grey Act. Briefly stated, its main provisions aim at improving the position of the native, and at the same time meeting his claim to a voice in the regulation of his own affairs by developing a system of local government based upon the tribal social organisation. A further resolution of the Association pointed out that any attempt to bring the native population into closer touch with the social and economic development of the country as a whole —the crucial problem of native legislation in South Africa—could hope to be successful only if it were based upon an intimate knowledge of native psychology and customs, and to this end it urged upon the Government of the Union the necessity for the establishment of an Ethnological Bureau for the collection of data and the study of native institutions.

Relativity.

DR. C. E. ST. JOHN gives in the *Observatory* for July some remarks on the search for the Einstein effect in the solar spectrum which was made last year by L. Grebe and A. Bachem at Bonn, and alluded to with approbation in a letter from Dr. Einstein, quoted in NATURE for January 29 last. Dr. St. John thinks that the dispersion of their spectrograph, 1 mm. per Å.U., was too low for work of this character, especially where the lines are so close together; further, the comparison spectrum was not photographed simultaneously, but before and after. The arrangements for eliminating the solar rotation are also not considered to have been exact enough.

Dr. St. John then goes on to criticise their suggested explanation for the failure of some other observers to detect the Einstein shift, which was, in short, that unsymmetrical emission lines become symmetrical in absorption. He shows that this neglects the light radiated by the vapour itself; since the absorbing vapour is at various depths in the sun, the probable result is shown to be an unsymmetrical absorption line. The further argument is made that many of the iron lines are unsymmetrical in the reverse direction to the carbon lines in question, so that if the explanation were true, these lines should give too large an Einstein effect, which they do not.

Dr. St. John concludes by saying that the object of his note is not to deny the existence of the Einstein effect, but merely to throw doubt on the completeness of the proof put forward by Messrs. Grebe and Bachem.

Astr. Nach., 5051, has an article by K. F. Bottlinger in which a possible astronomical test is suggested to distinguish between the relativist view of the speed of light and the earlier view of the stationary æther. He notes the very high radial velocities of the spiral nebulæ and clusters, and concludes that it is, *a priori*, likely that the velocity of our stellar system relatively to the æther is of the same order. If we take it as 1000 km./sec., and also assume that the direction of motion is not distant from the plane of the ecliptic, then eclipses of Jupiter's satellites will be alternately accelerated and retarded by some 14 sec., according as Jupiter lies towards the apex or antapex. The eclipses observed at Harvard make it pretty certain that there is no residual of this amount in the eclipse times; so that either the fixed-æther doctrine of light transmission is wrong or the speed of our system in the æther is only a small fraction of 1000 km./sec. This proposed test differs from the Michelson-Morley experiment in being a first-order effect, while that is of the second order.

University and Educational Intelligence.

Science of August 20 reports that the Harvard University School of Medicine has received 70,000*l.* from the Rockefeller Foundation for the development of psychiatry, and 60,000*l.* for the development of obstetric teaching.

THE *Chemist and Druggist* announces that the chair of chemistry in Berlin University, rendered vacant by the death of E. Fischer, will be filled by Prof. Haber, who will retain also his present position of director of the Emperor William Institute for Physical and Electro-Chemistry.

THE governors of the Northern Polytechnic Institute, Holloway, N.7, are, on September 27, opening a school of rubber technology. There will be day and evening courses designed mainly to train those who have already acquired a thorough knowledge of chemistry and physics and are now desirous of taking up responsible positions of a scientific and technical nature in rubber factories. The school will be in close touch with the industry, as it will be under an advisory committee composed of representatives of the manufacturers, producers, merchants, rubber engineers, etc. The director of the courses is Dr. P. Schidrowitz, who is a leading authority on rubber.

FROM the Simla correspondent of the *Pioneer Mail* for August 6 we learn that the text of the Muslim University Bill has been published. It is proposed to dissolve the Muslim University Association and the Mohammedan Anglo-Oriental College, Aligarh, and to transfer the property of these societies to a new body called "The Aligarh Muslim University." The Bill secures to the Government powers of control, and to the University the assurance of a permanent endowment. The University will be of the teaching and residential type, and its degrees will be recognised by the Government. Special features of the institution will be the instruction of Muslims in Muslim religious education, and the inclusion of departments of Islamic studies.

THE calendar of the Edinburgh and East of Scotland College of Agriculture for the year 1920–21 contains a detailed account of the courses of instruction available at this centre for the degree of B.Sc. of Edinburgh University, for the college diploma in agriculture, and for the college diploma in horticulture. Short courses in agriculture are provided during the winter months for the benefit of farmers and others who are unable to attend the full diploma course; these last for five weeks and extend over two years. In addition, a short course in forestry lasting four weeks may be given during the summer of 1921. The college also acts in an advisory capacity to farmers in the central and south-eastern counties of Scotland. Epidemics of insect or other pests on crops, trees, or live-stock are investigated, and information on farm and dairy management is always available. Manures and seeds for experimental work are tested at specially low rates with the idea of encouraging farmers to conduct experiments and trials in collaboration with the college staff.

THE current issue of the *British Medical Journal* is the annual educational number. As usual, it is addressed mainly to two classes: those who need information as to the course which must be followed in order to become legally qualified practitioners of medicine, and those who, having obtained qualifications to practise, are doubtful as to what particular branch of medicine they should choose as a career. The student is advised to aim at a university degree in medicine at the outset of his career, though it may be desirable to take also a diploma or licence. Warning is also given with regard to the question of expenses. The outlay involved in completing a medical curriculum varies, but 1500*l.* is reckoned to be the minimum for which the training can be accomplished at the present time. For the medical graduate, diplomate, or licentiate, once his name is on the Register of the General Medical Council, many paths are indicated; but he is reminded that whatever the branch of practice chosen, the main reward of medical life is the knowledge of good work well done. Against this it is urged that the spirit of the times is all in favour of the extension and co-ordination of the public health services. This has occasioned an increase in the official medical services, but their position is not well defined at present, and prospects of promotion are uncertain.

THE new session of the Sir John Cass Technical Institute, Aldgate, will commence on Monday, September 27. The courses of instruction provided are especially directed to the technical training of those engaged in chemical, metallurgical, and electrical industries and in trades associated therewith. Special courses of higher technological instruction form a distinctive feature of the work of the institute. The curriculum in connection with the fermentation industries includes courses of instruction in brewing and malting; in the history, cultivation, and use of the hop; and in the micro-biology of the fermentation industries. These courses are arranged for persons engaged in the practical and scientific control of breweries, maltings, and other fermentation industries who desire to acquire a knowledge of the technology and principles underlying their daily operations. A connected series of lectures on fuel and power is also included in the syllabus of the chemistry department for the forthcoming session. In the department of physics and mathematics special courses of lectures will be given in colloids, the methods employed in their investigation and their relation to technical problems; in differential equations and vector analysis; and in the theory and application of mathematical statistics. Full details of the courses are given in the syllabus of the institute, which can be had on application at the office of the institute or by letter to the principal.

ALTHOUGH the scientific study of human and animal nutrition is of even greater importance to this country than to the United States of America, it has attracted fewer workers and received far less financial support here than on the other side of the Atlantic. Consequently, the public-spirited munificence of Mr. John Quiller Rowett in contributing 10,000*l.* towards the endowment of an Institute for Research in Animal Nutrition in connection with the University of Aberdeen and the North of Scotland College of Agriculture is especially to be commended. The new institute, which will appropriately be named the Rowett Research Institute, has already secured the services of two first-rate investigators. Dr. J. B. Orr, the director, was recently associated with Prof. E. P. Cathcart in the conduct of a very important study of the energy output of soldiers, while Dr. R. H. A. Plimmer, chief biochemist in the institute, has had a distinguished career as a research worker in the Physiological Institute of University College, London. An agricultural correspondent, writing in the *Aberdeen Daily Journal* of July 9, directs attention to the enormous economic loss, estimated at 30 millions sterling per annum, due to diseases of animals and plants, while the unsatisfactory state of knowledge respecting problems of human nutrition and food-supply was the subject of a criticism by a committee of the Royal Society. It is obvious that no single institute can cope with the mass of work which urgently needs to be done, but the precedent just established is valuable, and the scientific colleagues of Drs. Orr and Plimmer will look forward with confidence to their future successes in a field of research so far inadequately cultivated.

Societies and Academies.

PARIS.

Academy of Sciences, August 2.—M. Henri Deslandres in the chair.—The president announced the death of Armand Gautier.—G. **Humbert**: The representation of an integral by indefinite Hermite forms in an imaginary quadratic body.—M. **Michkovitch**: Observations of the periodic comet Tempel II. made at the Marseilles Observatory with the Eichens equatorial of 26-cm. aperture. Positions for July 20 and 21 are given, with those of comparison stars. The comet was circular, diameter 5 to 6 seconds of arc, and magnitude 10·2. The nucleus was well defined.—R. **Jarry-Desloges**: Contribution to the study of telescopic images.—P. **Ditisheim**: The determination of the difference of longitude between Greenwich and Paris by chronometers carried by aeroplane. The regular aeroplane service between London and Paris was utilised for the transport of twelve chronometers. The general mean of sixty-one operations was 9m. 20·947s. ±0·027s. for the difference of longitude between Greenwich and Paris.—J. **Villey**: The application of Righi's method to the discussion of Michelson's experiment.—G. **de Rocasolano**: The ageing of colloidal catalysts (platinum, palladium). In the decomposition of hydrogen peroxide solutions by colloidal solutions of platinum, the velocity constant increases with the time between the preparation of the catalyst and its use, reaches a maximum, and then falls. Hydrosols of palladium exhibit similar phenomena.—Er. **Toporescu**: The removal of copper oxide and nickel oxide from solutions by precipitates of ferric oxide.—Ch. **Depéret** and P. **Mazeran**: The Bresse of Chalon and its Quaternary terraces.—L. **Mayet**, P. **Nugue**, and J. **Dareste de la Chavanne**: The discovery of a skeleton of *Elephas planifrons* in the Chagny sands at Bellecroix, near Chagny (Saône-et-Loire). This species has not, up to the present, been identified amongst the Pliocene elephants of Western Europe.—G. **Zeil**: Tectonic earthquakes and variations of latitude.—O. **Mengel**: Tectonic of the secondary synclinal of Amélie-les-Bains.—H. **Colin**: Crystallisable sugar and free acids in plants.—R. **Anthony** and J. **Liouville**: The characters of adaptation of the kidney of Ross's seal (*Ommatophoca Rossi*) to the conditions of aquatic life. The kidney of this seal presents the maximum of characters of specialisation, with respect to its aquatic life, met with amongst Pinnipeds. It is comparable with the kidney of Cetaceans of a primitive type, such as Mesoplodon.—L. M. **Bétancès**: The existence of thrombocytes in *Astacus fluviatilis*.—C. **Gessard**: A pyocyanic culture.—J. **Danysz** and Mme. St. **Danysz**: Attenuation of the pathogenic effects of certain micro-organisms by mixture with dead organisms of the same race.—M. **Fouassier**: The micro-organisms persisting in milk after pasteurisation: their *rôle* in the decomposition of hydrogen peroxide.

SYDNEY.

Linnean Society of New South Wales, June 14.—Mr. J. J. Fletcher, president, in the chair.—A special general meeting "in commemoration of the centenary of the birth of Sir William Macleay." The meeting was devoted to the presidential address, "The Society's Heritage from the Macleays," followed by an exhibit of mementoes of the Macleays. The many claims which the memory of Sir William Macleay has on the members of the society were recalled; details of the development of their interest in science of the direct line of the family, and the history of the Macleay collections up to 1874, were given. The mementoes exhibited consisted of portraits and copies of books and drawings of zoological interest, most of which had been presented to members of the Macleay family by their authors. Later, Prof. J. T. Wilson unveiled the society's Honour Roll, on which are inscribed the names of members who served abroad during the Great War.

June 30.—Mr. J. J. Fletcher, president, in the chair.—H. J. **Carter**: Notes on some Australian Tenebrionidæ, with descriptions of new species; also of a new genus and species of Buprestidæ. Thirty-three species of Tenebrionidæ belonging to eighteen genera (of which one is proposed as new) are described as new. As a result of the comparison by Mr. K. G. Blair of specimens with the types in the British Museum, a number of mistaken identifications are corrected and further synonymy is suggested. A re-examination of the species of the closely allied genera Dædrosis, Licinoma, Brycopia, and their allies has led to considerable modifications of tabulations previously published.—G. H. Hardy: The male genitalia of some robber-flies belonging to the sub-family Asilinæ (Diptera). The results of a study of a number of species of Australian robber-flies belonging to the subgenus Asilus indicate that the male genitalia afford a satisfactory basis for identifying the species. Eleven species (of which one is described as new) are dealt with and their male genitalia figured.

Books Received.

A Kinetic Theory of Gases and Liquids. By Prof. R. D. Kleeman. Pp. xvi+272. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 16s. 6d. net.

Electric Furnaces in the Iron and Steel Industry. By W. Rodenhauser, J. Schoenawa, and C. H. Von Baur. Translated and completely rewritten. Third edition, revised. Pp. xxi+460. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 24s. net.

Elementary Applied Mathematics: A Practical Course for General Students. By Prof. W. P. Webber. Pp. ix+115. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 7s. 6d. net.

Elementary Algebra. By C. V. Durell and G. W. Palmer. Part i. With Answers. Pp. xxxi+256+xlvi. (London: G. Bell and Sons, Ltd.) 4s. 6d.

Vaccination in the Tropics. By Col. W. G. King. Pp. 64. (London: Tropical Diseases Bureau.) 5s. net.

Das Schmerzproblem. By Prof. A. Goldscheider. Pp. iv+91. (Berlin: J. Springer.) 10 marks.

Elementary Practical Biochemistry. By Prof. W. A. Osborne. Pp. v+184. (Melbourne: W. Ramsay.)

Stones and Quarries. By J. A. Howe. Pp. x+137. (London: Sir I. Pitman and Sons, Ltd.) 3s. net.

Modern Explosives. By S. I. Levy. Pp. ix+109. (London: Sir I. Pitman and Sons, Ltd.) 3s. net.

Life in a Sussex Windmill. By E. A. Martin. Pp. v+118. (London: Allen and Donaldson, Ltd.) 6s. net.

The Elements of Practical Psycho-Analysis. By P. Bousfield. Pp. xii+276. (London: Kegan Paul and Co., Ltd.) 10s. 6d. net.

Catalysis and its Industrial Applications. By E. Jobling. Second edition. Pp. viii+144. (London: J. and A. Churchill.) 7s. 6d. net.

The Outline of History. By H. G. Wells. Revised and corrected edition. Pp. xx+652. (London: Cassell and Co., Ltd.) 21s. net.

The Victoria History of the Counties of England. A History of the County of Bedford. Part i., Geology, by J. Hopkinson and J. Saunders; Palæontology, by R. Lydekker, pp. 35, 3s. 6d. net. Parts iv. and vi., Early Man, by W. G. Smith; Anglo-Saxon Remains, by R. A. Smith, pp. 145–90, 5s. net. (London: Constable and Co., Ltd.)

Human Psychology. By Prof. H. C. Warren. Pp. xx+460. (London: Constable and Co., Ltd.) 12s. net.

George Stephenson. By Ruth Maxwell. Pp. 192. (London: G. G. Harrap and Co., Ltd.) 3s. 6d. net.

Memoirs of the Geological Survey, Scotland. The Mesozoic Rocks of Applecross, Raasay, and North-East Skye. By Dr. G. W. Lee. Pp. vii+93+plates. (Southampton: Ordnance Survey Office; Edinburgh: H.M. Stationery Office.) 6s. net.

Report on Compulsory Adoption of the Metric System in the United Kingdom. Pp. 70. (London: Conjoint Board of Scientific Societies.) 1s.

American Civil Engineers' Handbook. Edited by M. Merriman. Fourth edition, revised and enlarged. Pp. 1955. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 33s. net.

Topographic Maps and Sketch Mapping. By Prof. J. K. Finch. Pp. xi+175. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 13s. 6d. net.

The Control of Parenthood. By Prof. J. A. Thomson and others. Pp. xi+203. (London and New York: G. P. Putnam's Sons.) 7s. 6d. net.

An Introduction to Combinatory Analysis. By Major P. A. MacMahon. Pp. viii+71. (Cambridge: At the University Press.) 7s. 6d. net.

The Influence of Man on Animal Life in Scotland: A Study in Faunal Evolution. By Dr. J. Ritchie. Pp. xvi+550. (Cambridge: At the University Press.) 28s. net.

Exercises from Elementary Algebra. By C. Godfrey and A. W. Siddons. Vols. i. and ii. complete. With Answers. Pp. x+395. (Cambridge: At the University Press.) 7s. 6d. net.

Small Holding and Irrigation: The New Form of Settlement in Palestine. By Dr. S. E. Soskin. Pp. 63. (London: G. Allen and Unwin, Ltd.) 2s. net.

CONTENTS.

NATURE

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The British Association and National Life.

WE published a fortnight ago (Sept. 2, p. 13) some observations made by Dr. R. V. Stanford, our local correspondent for the recent meeting of the British Association at Cardiff, upon "the apathy of local people of the educated classes to the presence of the Association" in the city, and the neglect of the opportunity which such a meeting may afford of stimulating public interest in scientific achievements and their applications. There is, we believe, a feeling among many members of the Association that efforts should be made to increase its usefulness by bringing it into closer contact with thoughtful members of all classes of the community and encouraging a fuller representation of the new generation of scientific workers. Institutions, like organisms, must be adapted to their circumstances, or suffer eventual extinction. The British Association is still in a state of strong vitality, but it is not making progress; and not to be in touch with advancing times signifies retrogression.

It is easy to be satisfied with this condition, and to consider that all is of the best in the best of all scientific organisations, but that is not the spirit of development. There is no need for scientific men now to work in secret cells, and carry on their discussions in conclaves; on the contrary, the world is more eager than ever it was to learn and to use the results of scientific research. Whatever apathy exists on the part of the general public as regards these advances is due largely to the neglect of national bodies like the British Association to adjust themselves to changing national needs. The public does not understand the Association, and the Association makes little endeavour to show the bearing of scientific methods and principles upon most subjects of vital importance in national polity and industrial affairs.

When the Association was founded, in 1831, one of its first purposes was stated to be "to obtain a greater degree of national attention to the objects of science"—a phrase which in the present rules reads "to obtain more general attention for the objects of science." Whether the change was deliberate or not we do not know, but we prefer to think that "national attention" is what was originally intended, and we desire to urge that this aspect of the Association's activities should be given more consideration than it now receives, instead of concentrating upon the work of the sections. There were no sections when the Association began its existence, but only committees upon various branches of science. At the Cambridge meeting in 1833 the sections were: (1) Mathematics and Physics; (2) Philosophical Instruments and Mechanical Arts; (3) Natural History, Anatomy, Physiology; (4) History of Science. Chemistry, with Mineralogy, became a section in the following year, and Statistics formed a sixth section. Then came in succession Geology and Geography, Zoology and Botany, Mechanical Science, and various other changes, leading to the present denomination of sections. Anthropology became a section in 1884, Physiology ten years later, Botany in 1895, Educational Science in 1901, Agriculture in 1912, and at the recent Cardiff meeting the General Committee recommended that Psychology be promoted from a sub-section to a section, making thirteen in all. Each section is autonomous, and there is no co-ordinating committee to make them part of a composite organisation, or suggest how they may combine their forces for the common good. The Association is like a great industrial works in which each shop produces what it pleases, and no one has the duty of building up a noble structure from the various parts.

Two separate functions may be distinguished in the work of each section. One is the presentation of papers for discussion by workers in the particular fields to which they refer, and half-a-dozen such allied workers gathered together can gain more from one another by informal conversation than can possibly be elicited when their remarks are addressed to an audience without special knowledge of the subjects under consideration. If, however, a section is to be regarded purely as an assembly of specialists, and papers read are prepared on this assumption, then fifty sections would not be sufficient to meet the present-day differentiation of scientific subjects. As such subdivision is impracticable, intensive discussion is usually impossible, and very few members of a section are able to make profitable comments upon papers of a specialised kind. Authors ought not, indeed, to assume that a section as a whole consists of specialists in their own minute fields, but should address themselves rather to workers generally in a broad department of scientific activity. Members who attend any particular section do not expect to learn much that is new of their own special subjects, but they do want to know the chief lines of progress in related branches of work. A section ought not, in fact, to be addressed as a scientific or technical society, but as a Royal Institution assembly. Its main function should not be technical discussion by specialists for specialists, but the enlightenment of an extensive group of workers as to main lines of advance in fields not specifically their own.

We know, of course, that there are practical difficulties in ensuring generally intelligible discourses from men whose main interest is in actual research. Genius for discovery is not often associated with the art of literary or of vocal expression, so that it is not uncommon to find readers of papers and openers of discussions in sections offending the most elementary principles of public speaking. They converse with themselves instead of addressing the back row of their audience; if they use a lantern their slides are often mixed, and are usually changed by the irritating instruction "Next, please," long ago discarded by every public lecturer of any reputation; and if they use a blackboard, what they scribble upon it can be read by the front row only. All these sins of commission, as well as others of omission, may be forgiven when a circle is small and those who compose it are familiar with the details of the subject, but an audience which fills a section room has a right to expect its interests to be considered, and not to leave the room with a feeling of disappointment or in a more confused state than when they entered it.

There would not be the slightest difficulty in securing large audiences for joint meetings of several sections, interested in different aspects of broad scientific subjects, provided that reasonable care were devoted to the selection of the subjects and the opening speakers. The success of the symposia arranged by the Faraday Society through Sir Robert Hadfield's enterprise shows how keen scientific workers are to occupy a common platform and understand each other's contribution to a common cause. The organising committees of related sections of the British Association would perform a much greater service to the scientific community by united action on these lines than by accepting as their separate programmes a variety of papers of which few are novel or of wide interest. The separate action of sections upon matters of common interest was exemplified by four resolutions brought before the General Committee at Cardiff. The Section of Zoology condemned the views of the "Investigators" of the Secondary Schools Examination Council of the Board of Education that zoology was not so suitable as botany as a school subject; the Section of Geography asked that geography should be recognised by the Board as a subject for advanced courses in secondary schools; and that of Anthropology urged that work of a regional survey type should receive official encouragement and anthropometric measurements should be made of pupils in continuation schools. There is an Educational Science Section of the Association where all these subjects could be considered appropriately in joint session with the sections which brought them forward, yet the action was taken independently and without consultation with the very members who are supposed to be concerned with the development along scientific lines of all schools and scholars. A joint meeting of several sections on "Science and the School," or similar subject, might have suggested a means of adjusting the various claims made upon the curriculum and the resources of schools, and such a meeting should obviously have been held before the Council was asked to father resolutions of individual sections upon subjects which concern other sections also.

We mention this episode merely as an example of the fissiparous tendency of the sections, and as a reason for more frequently dissolving the membrane which separates contiguous cells. When joint meetings are arranged, however, it should be remembered that the larger the intended appeal the more general must be the subject selected, and that the greatest common factor of knowledge possessed by the audience will be correspondingly lower. Huxley once said that in a public lecture he addressed himself to the least intelligent member of his audience, and though it may not be essential for a speaker at a joint meeting of sections to accept this standard, yet if he wishes to claim the close attention of most of his hearers he should not soar so much above it as is commonly done.

What we have said as to the intensive and extensive functions of sections of the Association is on behalf of the general members, who are engaged in scientific education or research. No one waits for an annual meeting of the Association in order to describe a new discovery or announce a development, and as the Association does not publish papers, except by special resolution, there is nothing to induce authors, if they wish their work to be recorded, to make new communications to the sections. The chief aim should be, therefore, not a miscellany of papers of interest to a few specialists, but clear expositions of broad advances which appeal to the many. Beyond this duty of the Association to the general body of scientific workers is the even more important relation of the Association to national life and public interest. When the Association first met, and for many years afterwards, it was the only national peripatetic organisation of a scientific or technical kind. Now, however, the Institution of Naval Architects, Iron and Steel Institute, Royal Sanitary Institute, Society of Chemical Industry, Museums Association, Institute of Metals, and other bodies concerned with pure or applied science, hold their annual meetings at different places each year, and the Association no longer occupies a unique position in this respect. Notwithstanding this fact, the Association remains the only body which can represent the contributions of research to the whole field of progressive natural knowledge—whether applied or not—and we believe that a much larger public, in any place of meeting, would take active part in its work if greater consideration were given to wide national questions and the bearing of local conditions upon them.

The Association has come to be regarded as a technical or professional organisation, like the British Medical Association and similar bodies, with the result that the intelligent public in the locality where it meets takes little interest in it—at any rate, not so much as it did at one time. At the recent meeting in Cardiff, the total attendance was 1378; in 1891 it was 1497; and at almost every meeting in recent years the numbers have been less than at the previous meeting in the same place. Scientific workers are much more numerous than they were in the earlier years of the Association, and the fact that the attendance at meetings does not show a corresponding increase, but a decrease, is a sign that should not be disregarded by an organisation that desires to expand.

Unlike the other societies and institutions mentioned above, the British Association looks for members and support to the public in the locality in which its annual meeting is held. It cannot expect, however, to meet with the response desired unless it does much more to create and foster interest in local and national subjects with which science may be concerned, and by securing for the meetings the presence of prominent public men. Distinguished statesmen, great captains of industry, and leading representatives of labour should be approached, and we believe that many of them would be glad to range themselves on the side of scientific workers and testify to the national significance of contributions to national knowledge. There is no lack of subjects with which such men may be appropriately associated. What is lacking is the eloquent advocacy which well-known public men can give.

We are not alone in suggesting that a change of policy and of programme is needed to bring the Association into line with present conditions. Two of the technical journals—the *Electrician* and the *Chemical Age*—have each recently expressed regret that at the Cardiff meeting evidence of progress in electrical science, engineering, and chemistry was not prominently displayed by the papers presented to the sections devoted to these subjects; and they consider that the Association is now out of touch with the times. The former journal suggests that to make the annual meeting of greater interest to the public generally there should be a series of communications on the latest discoveries in physical science, the problems of electric traction, advances in wireless communication, domestic uses of electricity, and related matters in contact with daily life; and it remarks, "We do feel that at a time when electrical science is being more and more applied to the solution of industrial and domestic problems it is a pity that an opportunity such as the annual meeting of the British Association affords of placing what is being done in simple and, so far as possible, in non-technical language before the general public should have been so conspicuously missed."

Even technical men, therefore, do not look to the Association for specialised work, but for broad surveys of large regions and descriptions of outstanding peaks in scientific fields. Above all, they ask for attention to subjects of vital interest to the community, and this plea is the main object of the present article. The Association should stand not for esoteric, but for exoteric, philosophy, and thus bring within its sphere all who believe that progressive thought, with accurate knowledge, form the only sure foundation upon which man can build a structure that will withstand the polemic storms of the present and the world shocks which promise to assail it in the future.

Ewing's "Thermodynamics."

Thermodynamics for Engineers. By Sir J. A. Ewing. Pp. xiii+383. (Cambridge: At the University Press, 1920.) Price 30*s*. net.

ONE of the chief fascinations of thermodynamics is the way in which it ramifies into other branches of science, following the manifold transformations of energy. The fundamental laws reappear in so many different aspects in relation to the quantities which are the subject of measurement in the different branches, such as chemistry, electricity, radiation, etc., that it affords one of the most interesting standpoints from which to view the growth of natural philosophy and to study the correlation of its parts. For the same reason it is difficult for the worker in any one branch to follow the applications of thermodynamics to other subjects with the principles of which he is unfamiliar; and he is apt to find that the discussion of his own subject in a general survey is necessarily lacking in the practical details and numerical data which would be required to enable him to make any use of it for his special purpose. Accordingly it is usual in treatises on special subjects, such as steam turbines, or petrol motors, or refrigerating machines, to include one or more chapters on the principles of thermodynamics in relation to the subject discussed. This is a very natural compromise, but involves a great deal of repetition of elementary principles, while it frequently fails, owing to limitations of space or lack of generality, in providing a sufficiently solid foundation for further research. So much effort has been wasted in the past, and is still being wasted, by inventors and experimentalists, in pursuit of fancied improvements which a wider knowledge of thermodynamics would have shown to be illusory, that such knowledge should be regarded as an essential part of the equipment of the scientific engineer, however abstract and theoretical it may appear to the practical man at first sight.

Among English treatises on thermodynamics, few, if any, appear to have been written primarily from the point of view of the engineer. We are therefore all the more disposed to welcome a book with this object from a master of clear exposition, whose books on kindred subjects are already so well known and appreciated by engineers. The method adopted by the author of the present work is to begin with the elementary notions and their interpretation in practice, and to defer the mathematical relations until the reader may be supposed to have become familiar with the fundamental ideas as physical realities, and is presumably able to apply them to practical problems.

In pursuance of this general scheme, the first six chapters of the book deal with general principles, explained in the first instance in relation to ideal gases, and then applied to practical problems in discussing the properties of actual fluids, the theory of the steam-engine and of refrigeration, jets and turbines, and internal-combustion engines. Since the general principles of thermodynamics have not changed in the last few years, it naturally follows that most of the material employed in this part of the work is the same as in the author's previous books on "The Steam-engine and Other Heat-engines" and on "The Mechanical Production of Cold." But the material has been rearranged as a connected exposition of the principles, and brought up to date in minor particulars, such as the adiabatic equation for dry steam, and the effect of supersaturation on the discharge through a nozzle. Most of the problems discussed are so well worked out that there is little room for difference of opinion, and so clearly explained that it would be difficult to suggest any improvement. It is only when we come to more recent or debatable problems, especially where the experimental data are still uncertain, that it becomes possible in a few cases to criticise the author's views.

The importance of devoting adequate consideration to the properties of the working fluid as affecting the operation of a heat-engine has been more fully recognised in recent years. Accordingly the author has included in the chapter on internal-combustion engines a discussion of the effect of increase of specific heat at high temperatures, and has added an appendix on the molecular theory of gases, which should serve as a useful introduction to the theory of the variation of specific heat. In discussing this subject the author naturally follows in the main the views of his successor at Cambridge, Prof. B. Hopkinson, whose work he did so much to inspire. Prof. Hopkinson's view that the loss of efficiency, as compared with the ideal air-standard for a given compression-ratio, could be attributed entirely to the increase of specific heat, provides an effective working hypothesis, but the experiments of Sir Dugald Clerk on the variation of specific heat, and on the composition of the mixture shortly after the attainment of maximum pressure, appear to show that the question is not quite so simple. The later development of Hopkinson's own experiments on radiation in gaseous explosions by W. T. David indicates other factors which have to be considered in framing a complete theory, and may have an important influence on the design of engines for large units of power or for high speeds. The completeness or otherwise of combustion at the moment of maximum pressure may fairly be regarded as still an open question and a fit subject for further experiment.

In developing the general thermodynamic relations between the various properties of a substance, the chief difficulty is to make a selection among the many possible permutations. It need scarcely be said that the author makes a very judicious selection for the purpose in view, and develops chiefly those relations of the energy, entropy, and total heat, and of their coefficients, the specific heats and the cooling-effects, which are required in applying the principles of thermodynamics to the correlation of the properties of the working fluids employed in heat-engines. In the next chapter he proceeds to apply the general relations to particular fluids, defined by well-known forms of characteristic equation, showing how the equation selected determines the necessary relations between the coefficients. In this connection the author discusses the general properties of gases and vapours, as illustrated by Amagat's experiments at high pressures, and Van der Waals's equation for the critical state. But most of the numerical illustrations are drawn from the properties of steam at moderate pressures, as being the most important for engineering purposes and the most accurately determined by experiment. He shows how the formulæ employed secure exact thermodynamic consistency between the various properties, but he refrains from discussing the experimental evidence with regard to the particular values selected for the constants, because this is a separate question beyond the scope of pure thermodynamics.

At the same time the book is not without some bearing on physical experiment, because no modern experimentalist can afford to represent his results by purely empirical formulæ without inquiring how far they are consistent with other measurable properties of the substance investigated. This requires a knowledge of the thermodynamical relations, and the ability to apply them, which this book is intended to teach. Thus one of the practical uses of the thermodynamic relations is to find the form and slope of lines on diagrams, such as the Mollier diagram, which are becoming so popular among engineers. Mollier had great difficulty in constructing his diagram for carbonic acid near the critical point, owing to the scarcity and uncertainty of the experimental data. Most of the missing data have since been supplied by the experiments of Prof. Frewen Jenkin and Mr. D. R. Pye, who made great use of thermodynamic relations in constructing their diagram, and incidentally showed that some of Mollier's lines were of an impossible shape. They had some difficulty, however, in fixing the form of the saturation line for the liquid, which appeared to show a point of inflexion a few degrees below the critical point. The author suggests that the point of inflexion should be at the critical point itself. This is in some ways an attractive suggestion, but the proof does not seem to be quite conclusive, and would be difficult to reconcile with the orthodox view of the critical state, according to which the critical isothermal itself possesses this property. It is possible that the singularity at the critical point may be of a nature different from that commonly assumed. It would be difficult to decide such a point by experiment, but it is just in such cases where experiment fails that thermodynamics is most useful.

H. L. C.

Forensic Medicine.

A Handbook of Medical Jurisprudence and Toxicology for the Use of Students and Practitioners. By Dr. W. A. Brend. Third edition, revised. (Griffin's Medical Pocket-book Series.) Pp. xiii+317. (London: Charles Griffin and Co., Ltd., 1919.) Price 10s. 6*d*. net.

THIS edition has been revised and enlarged. The chapter on the legal relationships of insanity and other abnormal states of mind, which has been entirely rewritten, gives a very good account in a brief and concise form of a branch of forensic medicine which usually presents difficulties to the medical student and practitioner. Chap. xvii., dealing with "Medical Privileges and Obligations," is excellent, and gives in a collected form the duties and responsibilities which may devolve upon a medical practitioner as a result of his registration by the General Medical Council. This subject has been much neglected in most of the existing text-books on forensic medicine, and the present edition of this work supplies a much-needed want by providing valuable advice on the line of conduct to be adopted by medical men in the many difficult situations which are likely to arise in medical practice.

The various chapters on forensic medicine and toxicology are well written, but a few points need correction and revision in a future edition. For example, in reference to "exhumation" it is stated that disinfectants should be freely used. The use of disinfectants in exhumations should, on the contrary, always be avoided, since in suspected poisoning, which is a common reason for exhumation, the use of disinfectants is likely seriously to complicate the analysis. A classical example of this was the Crippen case, where the sprinkling of a disinfecting powder containing carbolic acid and traces of arsenic on the remains added considerably to the difficulties of the analysis.

In the chapter dealing with blood-stains reference should have been made to the benzidine test. Also sufficient importance is not attached to the serum test for human blood, which must now be regarded as being trustworthy, and one of the routine tests which should always be adopted in the examination of blood-stains in order to determine with certainty that they are those of human blood and not of other animals, such as sheep, horse, ox, etc.

We do not find any account of the influence of status lymphaticus in cases of sudden death. In the chapter on abortion there is no mention of the effect of quinine and pituitary extract, which are powerful abortifacients. Reference should have been made to the changes introduced during the war with regard to the procedure in coroners' courts. In the chapters on toxicology one would wish to have seen some description of the poisons, such as tetrachloroethane, trinitrotoluene, etc., which were responsible for so many cases of fatal jaundice amongst munition workers.

The book claims to be a handbook of medical jurisprudence, and as such it has certainly justified its publication, for it will be most useful to students for examination in forensic medicine and to medical practitioners.

Industrial Administration.

Industrial Administration: A Series of Lectures. By A. E. Berriman and Others. (Publications of the University of Manchester. No. cxxxi.) Pp. vii + 203. (Manchester: At the University Press; London: Longmans, Green, and Co., 1920.) Price 7*s*. 6*d*. net.

THE lectures published in this volume were delivered in the department of industrial administration in the College of Technology, Manchester, during the session 1918–19, by various well-known authorities on subjects relating to industrial administration. Mr. Seebohm Rowntree discourses on the "Social Obligations of Industry to Labour," and endeavours to fix the minimum wage compatible with the maintenance of a working man and his family in decency and moderate comfort. In answer to the question: "Can industry afford to pay the minimum wages indicated?" he believes that the principal source to which we must look for increased wages is increased efficiency in the organisation and administration of industrial enterprises. Many British factories are run on very inefficient lines, with antiquated machinery and ill-trained staff and workers, and in such cases the profits are inconsiderable even when wages are low.

A most interesting and striking lecture on "Occupational Diseases" was given by Dr. T. M. Legge, who, in his capacity as Medical Inspector of Factories, has been largely responsible for the precautions taken to abate the evils of certain industrial processes. The success of the precautions may be judged from some of the figures he quotes. Whilst in 1900 there were 358 cases of lead poisoning among white-lead workers, and 200 among pottery workers, in 1913 the cases were reduced to 29 and 62 respectively. Of more recent interest are the cases of trinitrotoluol poisoning, which developed with alarming frequency in the latter half of 1916. There were 43 fatal cases in the six months, and another 32 fatal cases in the first six months of 1917, but by that time the chief cause of the poisoning—viz. absorption through the skin—was tracked down, and suitable precautions were taken. In the next six months fatal cases fell to 12, and in the following year to 10.

Other lectures deal with the applications of psychology to industry, industrial fatigue, and education in factory management and administration, whilst Dr. L. E. Hill gives an interesting account of his well-known investigations on "Atmospheric Conditions and Efficiency" by means of the katathermometer. Perhaps the lecture of most general interest is that on "Industrial Councils," by Mr. T. B. Johnston. The national council recently formed in the pottery industry is described in some detail, and it is to be hoped that in course of time similar councils will be formed in all the other staple industries. Equal numbers of representatives of the manufacturers and of the operatives sit on all committees, and they not only consider questions relating to wages, employment, and the conditions of production, but also encourage research into the industry, and consider inventions and improvements designed by the workpeople. Most important of all, the employers disclose full details of wages and profits, so that the workpeople can determine whether they are being fairly treated or not, and at the same time the consumer can ascertain whether the prices he is charged are due in any degree to profiteering. As Mr. Johnston rightly points out, "the first essential to a better understanding between Capital and Labour is that all the cards should be laid on the table."

H. M. V.

Fuel Economy.

The Use of Low-grade and Waste Fuels for Power Generation. By John B. C. Kershaw. Pp. x+202. (London: Constable and Co., Ltd., 1920.) Price 17s. net.

THE great increase in the cost of coal has naturally directed the attention of users of fuel to the question of fuel economy, the possibilities of which lie in two directions—the utilisation of lower-grade fuels and waste combustible material, and the more efficient utilisation of all fuels. Mr. Kershaw's book deals adequately with both these aspects of this important question. His earlier chapters are devoted to the consideration of peat, wood waste, small coal and washery waste, and other minor combustibles. In his second section he deals with fuel sampling and analysis and with the scientific control of combustion in practice.

Mr. Kershaw defines low-grade solid fuel as containing more than 25 per cent. of ash and 10 per cent. of moisture, or, in all, 35 per cent. of incombustible material. The cynic may remark that such a definition covers most of the coal at present marketed! Small coal, however, no matter what its ash and moisture content, is also "low grade," and the author includes all coal and coke passing a ½-in. mesh sieve.

Means are available, and Mr. Kershaw describes them clearly and discusses their merits lucidly, by which the lower-grade fuels may be utilised, but possibly, because of present economic conditions, the more general utilisation of low-grade coal and colliery refuse will be confined to the large, centralised power schemes which have been recommended, and individual consumers will more specifically seek economy in the better utilisation of the class of fuel they have been accustomed to use, and for which their plants can be adapted with but little expenditure. Mr. Kershaw's treatment of this side of the question is adequate and practical, and he is to be congratulated on producing this small volume at this opportune moment, for it is one to command the attention of all interested in the use of fuel for every industrial purpose.

Text-books of Chemistry.

(1) *An Introductory Course in Quantitative Chemical Analysis, with Explanatory Notes, Stoichiometrical Problems, and Questions.* By Prof. G. McPhail Smith. Pp. x+206. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1919.) Price 9s. net.

(2) *Quantitative Analysis by Electrolysis.* By A. Classen, with the co-operation of H. Cloeren. Revised, rearranged, and enlarged English edition by Prof. W. T. Hall. Pp. xiii+346. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1919.) Price 17s. 6d. net.

(3) *Industrial Organic Analysis: For the Use of Technical and Analytical Chemists and Students.* By Paul S. Arup. Second edition, revised and enlarged. Pp. xi+471. (London: J. and A. Churchill, 1920.) Price 12s. 6d. net.

(4) *A Foundation Course in Chemistry: For Students of Agriculture and Technology.* By J. W. Dodgson and J. Alan Murray. Second edition, thoroughly revised. Pp. xii+241. (London: Hodder and Stoughton, Ltd., 1920.) Price 6s. 6d. net.

(5) *Chemistry in Everyday Life: Opportunities in Chemistry.* By E. Hendrick. Pp. xii+102. (London: University of London Press, Ltd., 1919.) Price 3s. 6d. net.

IN the multiplicity of text-books one naturally looks for evidence of the trend of progress as demonstrated in new editions and new volumes. We want to find the aim of the author and why he has considered it desirable to add one more to the books that are already so many that the teacher and the student find it difficult to select the one that will suit them best.

(1) Prof. Smith says of his manual that it is for those who have completed courses in elementary chemistry and qualitative analysis and are beginning work in quantitative analysis. We are glad to see, so far as this is evidence of it, a return to the natural sequence of quantitative following qualitative work. The student at this stage ought to be able to appreciate the introductory section in which the author, after some excellent advice, proceeds to consider the balance, its use and care, methods of weighing, the calibration of weights, various errors and their elimination; the precipitation, filtering, and washing of precipitates, in which he uses the theories of modern physical chemistry; drying, ignition, evaporation, and the use and calibration of volumetric apparatus. The student is thus well prepared to work intelligently, but throughout the book, although the instructions are definite, almost every direction is accompanied with the

reason for the procedure. So the student is helped to study and not merely to perform. One evidence of progress is the appreciation of the filter-pump at its true value: "When paper filters are employed, the use of a vacuum pump to promote filtration is of doubtful advantage in quantitative analysis"; its disadvantages "more than offset the possible gain in time." While the volumetric section is more extended than usual, the number of gravimetric exercises of a simple kind seems to us unduly few. After the determination of chlorine, iron, and sulphuric acid in simple salts, we pass to sulphur in an ore, phosphoric anhydride in a phosphate rock, and so on. Still it is better to do little thoroughly than much superficially. The ten pages devoted to the electrolytic determination of copper (1) with stationary electrodes, (2) with a rotating anode, is a part in which we think a few more practical exercises might have been introduced with advantage, but perhaps time does not permit of this in the laboratories of the University of Illinois.

(2) Prof. Hall has prepared this edition of "Classen," from the translation made six years ago, without further reference to the German text. Some new procedures have been added, and the order and the theoretical explanations have been somewhat modified. He says: "A simple application of the modern electronic theory seems to clarify rather than befog the vision of the beginner. An attempt, therefore, has been made to apply this theory a little more closely than has been done in most of the other well-known books on the subject." After 100 pages of introductory matter which describes in general terms electrolysis and the various details that affect it and its applications in analysis, the practical methods of determining twenty-nine metals are described, then methods of separating thirteen of the commoner metals from great varieties of other metals, and finally the electrolytic analysis of a considerable number of industrial products. The comparisons of various methods of depositing the different metals are often tabulated, so that a great amount of information is given in a comparatively small space, and the references to original communications being numerous, the student can turn at once to the full accounts of investigations if he wishes to pursue any particular matter. This edition of an authoritative treatise will be welcomed by all who are interested in the subject.

(3) In preparing the second edition of "Industrial Organic Analysis" Mr. Arup has added a chapter on sugars, some recently published methods, and references to the literature of the subject-matter. This last is an especially valuable feature, because the author has prepared the volume for those who have had a "thorough training in chemistry and physics," and are therefore able to take full advantage of such assistance. The author not only gives methods of analysis, but also describes the details of manufacture or treatment of the material dealt with so far as is necessary to carry out with intelligence the analytical process and to interpret usefully the results. The subjects treated of are coal and coke, coal-tar and its distillation products, fatty oils and fats, soap, petroleum and its distillation products, milk and butter, starch and its decomposition products, flour, barley, and malt, sugars and alcohol, and preservatives and colouring matters in foods. These headings are interpreted liberally; for instance, we have under one or the other infants' foods, margarine, cocoa, the sterilising and pasteurising of milk, and so on. The author is eminently practical, but in no sense merely empirical.

(4) It will probably long remain a debatable matter whether a student's elementary course in chemistry should be pursued with a definite aim as to the use he is ultimately to make of it. This means more or less passing over subjects that appear to be of little or no importance to him, and expanding the treatment of matters that appear to bear specially upon his future work. But the future may bring into prominence the very subjects that are scantily treated. The authors in their "Foundation Course" include, besides general chemistry and a consideration of various inorganic materials, a little organic chemistry, devoting forty-four pages to aliphatic compounds and five pages to aromatic compounds. Physical chemistry is dealt with in twenty pages. To this extent the book provides a good general introduction to these subjects.

(5) Mr. Hendrick, with few exceptions, gives sound information and good advice in his little volume, but it is marred by a familiar style and such statements as "the temperature of the electric arc, which is about as hot as sizzling sinners getting their reward." C. J.

Oil Geology.

Popular Oil Geology. By Prof. Victor Ziegler. Pp. viii+149. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1918.) Price 11*s.* 6*d.* net.

TO render any scientific subject into easy reading, to make such reading void of technical details while keeping strictly within the limits of accuracy and precision, is a problem tackled by many, but overcome only by few. To this few we may add the name of Victor Ziegler, who, in his

"Popular Oil Geology," has produced a remarkably neat and illuminating little volume which may be confidently recommended to all interested in the subject of petroleum technology.

Prof. Ziegler has condensed a very large subject into a comparatively small space, and it must be admitted that in but few instances have the principles of the science suffered from this treatment. The author has the obvious knack of extracting the real substance of the various branches of oil geology, and of presenting this without unnecessary "padding," so that the book really achieves its purpose of being an introduction to larger volumes dealing in more detail with the principles of the subject.

The chapters on the laws of the migration and accumulation of oil and gas, on oil structures and oil fields, and on prospecting are particularly good, while the final remarks on oil investments, culminating in a parody of John Hammond's rules for investors, are quite as amusing as they are apposite.

The book is profusely illustrated, a great many of the maps and diagrams being taken from the U.S. Geological Survey publications, as acknowledged in the preface. While this practice of reproduction is useful within limits, it is one that can be very easily overdone. To say that it shows lack of originality is possibly an exaggeration, but when such diagrams as that included on p. 77 occur again and again in various American publications we have examined, it seems disappointing that a new rendering of the same subject cannot be invented. But for that and the price (which for a book of this description is rather excessive), this little volume deserves a place on the bookshelf of the layman, student, and expert alike.

H. B. Milner.

Our Bookshelf.

Ozone. By Prof. E. K. Rideal. (A Treatise of Electro-chemistry.) Pp. ix + 198. (London: Constable and Co., Ltd., 1920.) Price 12*s*. net.

In recent years ozone has attracted increasing interest on account both of its value as an aid to research in organic chemistry, and of its actual or possible applications on the industrial scale. The literature of the subject is, however, widely scattered, hence in compiling this monograph, which forms a section of the treatise on electrochemistry in course of production under the editorship of Mr. Bertram Blount, the author has done good service to chemists.

An interesting introductory portion, which deals with the early history, the general properties, and the occurrence of ozone, is followed by five chapters in which the methods of production—chemical, thermal, and electrolytic—and in particular production by means of ultra-violet radiations and of the silent electric discharge, are adequately described. These are succeeded by a summary of the principal investigations on the catalytic decomposition of ozone, and in the next chapter its more important industrial applications—*e.g.* in the sterilisation of water, the "purification" of air, the bleaching of oils and fats, and the manufacture of vanillin—are discussed in some detail. The last chapter contains an account of the methods of detecting and estimating ozone.

The author has been distinctly successful in his effort to collect and correlate the various references to ozone which occur in chemical literature, and his monograph will be welcomed if only for that reason. In addition, it contains a valuable summary of what is known—after all not very much—about ozone, and by indicating problems which remain to be solved should also serve to promote investigation. It is therefore all the more regrettable that several of the pages of an otherwise praiseworthy book are disfigured by grammatical errors, or by sentences so carelessly constructed as to be obscure in their meaning.

Microscopy: The Construction, Theory, and Use of the Microscope. By Edmund J. Spitta. Third edition. Pp. xxviii + 537 + xxviii plates. (London: John Murray, 1920.) Price 25*s*. net.

The first edition of this work was reviewed in Nature for February 6, 1908. The work has gained a well-deserved popularity, and two further editions have since been called for. In each of these the opportunity has been taken to bring the subject-matter so far as possible up to date, and to indicate important new developments. In the present edition may be noted especially the reference to low-power objectives designed to give great depth of focus and a flat field, valuable especially for the photography of relatively large specimens of appreciable thickness, where good definition has to be obtained of parts lying in different planes. To illustrate the use of these, a considerable number of new plates have been added, which include some admirable reproductions of photographs obtained with modern objectives of this type.

Mention must also be made of the photographs added to illustrate the use of the term "critical definition." Unfortunately, the term, though no doubt convenient, is not one to which a precise significance can be given, and it thus always presents difficulties to the learner, who comes to appreciate only by experience the sense in which it is employed.

The "Addenda," amounting to more than twenty pages, contain useful notes of some recent improvements, with a few convenient tables. Attention is directed especially to the use of the newer Kodak filters for obtaining blue light with a powerful illuminant, details being given. The index has been improved and additional references have been inserted, notably those to the pages of the text in the descriptions of the plates, which are of material assistance. In short, the third edition exhibits throughout the same careful attention to detail as its predecessors, and the work fully maintains its position as the most valuable handbook to the practical use of the microscope as an optical instrument.

Oil-Finding: An Introduction to the Geological Study of Petroleum. By E. H. Cunningham Craig. Second edition. Pp. xi+324+xiii plates. (London: Edward Arnold, 1920.) Price 16*s.* net.

THE second edition of this work has been enlarged to nearly double the bulk of the first, the scheme remaining the same, and there is little to add to the review which appeared in NATURE of August 8, 1912, except to say that the revision of the work has distinctly improved its quality. The author is still insistent on the importance of the theory of the origin of petroleum, and for him that of vegetable origin and subsequent concentration, controlled by geological structure, is supreme. The treatment of this subject, regarded as of vital importance, is inadequate, in so far that less than six pages are devoted to theories of inorganic origin, and thirty-four to a polemical examination of the hypotheses of animal or vegetable origin; yet there are many facts in the known distribution of petroleum more easily explicable on the supposition of inorganic than on that of organic origin. At present there are grave difficulties in the way of regarding either as even approximately complete, and there is this to be said for the theory and principles of application advocated by the author, that they will lead to correct conclusions in about nine cases out of ten, and in the tenth success will depend mainly on luck, instinct, or intuition. The chapters on field-work are very distinctly improved, the approximate and imperfect methods indicated being relegated to their proper place, as expedients which may have to be resorted to by force of circumstances, and not, as inexperienced readers of the first edition might easily be led to believe, preferable to more exact and thorough methods.

Keys to the Orders of Insects. By Frank Balfour-Browne. Pp. vii+58. (Cambridge: At the University Press, 1920.) Price 7*s.* 6*d.* net.

MR. BALFOUR-BROWNE has placed students under an obligation by publishing this useful series of tables, founded on notes drawn up for those who have the advantage of attending his courses of entomology at Cambridge. The twenty orders of insects recognised are first distinguished by means of a "key," and then the families of those six orders that may be regarded as of greatest economic importance—the Orthoptera, Rhynchota, Lepidoptera, Coleoptera, Diptera, and Hymenoptera—are further discriminated. The characters given are those of adults only; but in later editions the author proposes to deal with some of the larval forms. It is to be hoped that these tables will serve to familiarise the rising generation of entomologists with the Comstock system of nomenclature for wing nervuration, and to hasten its use—perhaps with the modifications rendered necessary by Dr. Tillyard's recent researches—among special students of all orders of insects. Some points of detail in the tables need correction. It is implied that all Thysanura have the jaws retracted within the head; this is not the case with the two most conspicuous families, Machilidæ and Lepismidæ. Palps are not present in the Anoplura and Rhynchota; probably "absent" was meant, but "present" has been printed. In a new edition it would be well, if possible, to break up the unnatural group "Polymorpha" among the beetles, and it is to be hoped that the sale of the book may enable the publishers to reduce the price, which must be considered high, although blank interleaved pages have been considerately provided for students' notes.

G. H. C.

Catalogue of the Lepidoptera Phalaenae in the British Museum. Supplement. Vol. ii.: *Catalogue of the Lithosiadae (Arctianae) and Phalaenoididae in the Collection of the British Museum.* By Sir George F. Hampson. Plates xlii–lxxi. (London: British Museum (Natural History), 1920.) Price 32*s.* 6*d.*

THE present volume is supplementary to vol. iii. of the great Catalogue of Lepidoptera Phalænæ. Owing to the European War it has remained in manuscript since 1915, but has been brought up to date so far as possible. It includes no references to German publications which have appeared since August, 1914, for the reason just mentioned. Two families of Lepidoptera are dealt with—the Lithosiadæ (Arctianæ) and the Phalænoididæ. Of the former, vol. iii. included 147 genera and 845 species, and to these are added in the present work twenty-five genera and no fewer than 1215 species. Of the second family (Agaristidæ of many authors), the original numbers are increased by seven genera and eighty species. In his selection of family and generic names Sir George Hampson has adopted views on nomenclature which have been largely rejected by most systematists, but he has wisely adhered to the system utilised in the already issued volumes. We need only add that the book is well printed and up to the standard of the previous parts of the catalogue.

Historical Geography of Britain and the British Empire. (In two books.) Book I. *The Making of England; The Making of Empire; The Establishment of Empire:* B.C. 55 *to* A.D. 1815. By T. Franklin. Pp. viii+216. (Edinburgh: W. and A. K. Johnston, Ltd.; London: Macmillan and Co., Ltd., n.d.) Price 2*s.* net.

BOOK I. is divided into three sections; the first deals with the growth of England from the time of the Roman invasion to the beginning of the sixteenth century, the second with the building-up of the British Empire during the two succeeding centuries, and the third with the establishment and consolidation of the Empire. Geography plays a minor part in the book, and the title is therefore likely to be misleading. Nevertheless it is refreshing to find a school history in which the author has departed from the time-honoured custom of subdividing his work according to the number of monarchs with whom he intends to deal.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of Nature. *No notice is taken of anonymous communications.]*

"Spiranthes autumnalis" in Scotland.

Great is the debt which British botanists—experts and amateurs alike—owe to the authors of the "Handbook of the British Flora." It is scarcely possible to imagine a simpler or more convenient key to the natural orders. But a good deal has been added to our knowledge of British plants since the last revision of the work by Sir Joseph Hooker forty years ago, and it is to be regretted that before the latest edition was published in 1918 it was not passed through the hands of a competent editor to bring the work up to date. For instance, it is stated that the little orchid, *Spiranthes autumnalis*, is found nowhere north of Yorkshire and Westmorland. I had always accepted this as gospel until last August, when, while exploring a wood on Speyside for *Linnaea borealis*, I came upon a little colony of "lady's tresses." Since then I have received trustworthy information that Spiranthes grows in the valley of the Nairn.

I do not know whether this addition to our Scottish flora has been recorded hitherto.

Herbert Maxwell.

Monreith.

Associated Squares and Derived Simple Squares of Order 5.

The six different types shown below are distinguished by the position of the complementary numbers (1, 25; 2, 24; 3, 23, etc.):

A

25	10	3	9	18
11	20	5	22	7
2	14	13	12	24
19	4	21	6	15
8	17	23	16	1

B

20	11	5	22	7
10	25	3	9	18
14	2	13	12	24
4	19	21	6	15
17	8	23	16	1

C

6	4	21	19	15
22	20	5	11	7
12	14	13	2	24
9	10	3	25	18
16	17	23	8	1

D

25	18	3	9	10
11	7	5	22	20
2	24	13	12	14
8	1	23	16	17
19	15	21	6	4

E

25	18	3	10	9
11	7	5	20	22
2	24	13	14	12
19	15	21	4	6
8	1	23	17	16

F

25	10	3	18	9
19	4	21	15	6
2	14	13	24	12
11	20	5	7	22
8	17	23	1	16

Constant 65.

A is an associated square, and by means of Dr. Planck's method of complementary differences it has been found that there are 3034 squares of this type, and each one can have sixteen inversions, making a total of 48,544 squares.

B. By exchanging the first and second numbers in both rows and columns of A, type B is obtained. There are thus 48,544 squares of type B.

C. By exchanging the first and fourth numbers in both rows and columns of A, type C is obtained. There are thus 48,544 squares of type C.

D. Every associated square cannot be converted into type D, but by means of Dr. Planck's method of complementary differences the number can be found. It is 972, and each one can have one inversion, making a total of 1944.

E. But 36 of these 972 can be converted into type E, and each one can have three inversions, making a total of 144.

F. Also the same 36 of type D can be converted into type F, and each one, again, can have three inversions, making a total of 144.

In the last three types, squares can be constructed for each type by taking the columns as the rows and *vice versa*, and I have included these in the totals. This obviates the necessity of including types of squares when these three types are turned round through a quarter of a circle.

Totals:

A	...	48,544
B	...	48,544
C	...	48,544
D	...	1,944
E	...	144
F	...	144
		147,864

These are only six out of thirty-four types of 5th order, making a total of nearly 700,000 squares.

J. C. Burnett.

Barkston, near Grantham, Lincs.

The Spectrum of Nova Cygni III.

Cloudy and hazy nights have seriously interfered with spectroscopic observations of this nova at Stonyhurst, but some good photographs of the spectrum were obtained with the Whitelow short-focus prismatic camera on the nights of August 29 and 30 and September 6 by Father J. Rowland. The spectrum, the bright band spectrum characteristic of the second stage in the progressive spectra of novæ, remained practically the same during that interval. The bright hydrogen bands extended, on the average, over 20 Å. units, and consisted each of two components. There was a bright extension on the violet edge of H_ζ, about λ 3870, which was possibly the first sign of the incoming of the nebular band.

Besides hydrogen, the most prominent radiations were due to enhanced iron lines, 5316, 5169, 5019, and 4924. On September 6, 4924 alone of the four radiations named left an impression on an isochromatic plate. Between H_β and H_γ were two prominent and very broad bright bands, the first extending from λ 4703 to 4628, and the other marked by three maxima corresponding to the iron lines λ 4584, 4550, and 4516. Between H_γ and H_δ were three very prominent radiations, λ 4303 iron, 4228, and 4170, the last being almost as intense as H_δ. The K calcium band was also doubled, and extended over about 15 Å. units. On August 29 the spectrum extended far into the violet. On September 6 the visual magnitude was estimated as lower than the fifth. No obvious change in the spectrum could be detected on a weak impression secured on September 10. The iron line 4924 was still present. H_ϵ was very brilliant.

A. L. Cortie.

Stonyhurst College Observatory, Blackburn.

The Timbers of Commerce.[1]

A BOOK dealing with timbers in general is very welcome. The text-books in English on this subject give, as a rule, little information on the uses and commercial aspects of the numerous species which are imported into this country. There is one exception—Laslett's small book on "Timber and Timber Trees," which is still valuable, though in some respects out of date, the last edition having appeared in 1894. Other works, good as regards the microscopical structure of a considerable number of woods, fail to throw much light on their manifold uses and special properties.

Mr. Howard's work consists mainly of a descriptive account of the commercial uses of a great number of timbers, which are listed in alphabetical order, the botanical and vernacular names being indiscriminately used. This arrangement is open to criticism, as it occasionally mingles together species which have little in common but their trade name, and disjoins others which belong to the same genus—*e.g.* basswood (p. 23) and lime (p. 122), species of Tilia. Two indexes do away, however, with this difficulty. The title is somewhat misleading, as the timbers enumerated and described are not world-wide, but are practically confined to those imported into London and Liverpool. No attention is paid to any others. One fails to find, for example, an account of interesting woods like that of the nettle-tree (Celtis) in France, or of the sandarac wood (Tetraclinis) of Algeria, the latter remarkable for its subterranean burrs, out of which beautiful articles of cabinet-ware have been made from the time of the Cæsars to the present day.

Oak Grove, Kyre Park, Worcestershire. (From "A Manual of the Timbers of the World.")

Mr. Howard was, however, wise in limiting his subject to the timbers of which he has first-hand knowledge, and this inspires confidence in the facts that he discloses. With more than forty years of experience in the timber trade he is able to give his own personal opinion upon the merits and characteristics of a great number of species. The book, in short, is excellent on the commercial side. A scientific treatise on timbers in general has yet to be written. Such a work would contain a clear account of the structure of the woods concerned, and of their provenance, properties, and defects, and would point out how and why each species is adapted to the special purposes for which it is used. Mr. Howard's book is incomplete in these respects, and is, moreover, devoid of references to the numerous special papers and publications that have appeared on many species. Nevertheless, it is a valuable addition to the library of the merchant, the engineer, the architect, and the student at the present juncture. The British Empire Timber Exhibition, lately held, showed the wealth of timbers possessed by our Dominions, Colonies, and India, many of which are totally ignored by manufacturers and little known in the trade. Mr. Howard's book will awaken interest and disseminate valuable information.

"The Timbers of the World" is attractive in appearance, being illustrated by a series of repro-

[1] "A Manual of the Timbers of the World, their Characteristics and Uses." By A. L. Howard. Pp. xvi+446. (London: Macmillan and Co., Ltd., 1920.) Price 30s. net.

ductions from excellent photographs of timber operations and forest scenes in many parts of the British Empire. The inclusion in the work (pp. 328–84) of the tables of strengths of woods, which were published by Laslett, is probably justified by the fact that Laslett's book is out of print. These tables are of considerable value, but as Laslett had not at his disposal apparatus for determining the moisture contents of the woods examined, the figures are not so trustworthy as they seem. It would certainly be preferable in future, as Mr. Howard admits, to conduct experiments on woods "with some named and specific percentage of moisture." Moreover, we are now aware, thanks to the numerous tests carried out of late years at the Forest Products Laboratory, Madison (U.S.A.), that there is a remarkable variation in the properties of timbers of the same species from different logs and from different localities. That timbers are in no way comparable with metals in the uniformity of their physical characteristics is of course well known.

A chapter on the artificial seasoning of timber, with a note on laboratory and working tests, contributed by Mr. S. Fitzgerald, will prove useful.

There are errata and misstatements in this book, but they are not of a kind to detract much from its real value, which consists in the thoroughly practical nature of the information given on the uses, conversion, and utilisation of so many kinds of timber. Some of the inaccuracies may, however, be pointed out. It is, unfortunately, not true that, as stated on p. 118, "larch disease has practically disappeared." The explanation of the name "sycamore" on p. 266 is entirely erroneous, and is an instance of the strange fascination that wrong etymology has for many people. The word "sycamore" was originally applied in Greece to a species of Ficus, and is now transferred in England to the large-leaf maple, *Acer pseudoplatanus*, and in America to the Western plane, *Platanus occidentalis*. A whole page—p. 164—is devoted to the etymology of the term "wainscot oak," about which there is no doubt. It could have been expressed in three lines. "Wainscot" is derived from a Dutch word (fourteenth century) which means "oak wood with a wavy grain"; in other words, "wainscot oak" is "figured oak." Mr. Howard misquotes Skeat, who ("Concise Etymological Dictionary," p. 597) expressly warns the reader against the wrong derivation attributed to him by Mr. Howard. A regrettable error occurs on p. 211, where *Abies pectinata*, the European silver fir, is called "silver spruce." As is pointed out on pp. 262–63, the latter name can be applied only to the Sitka spruce (*Picea sitchensis*). Endless

Fine example of African mahogany curl. (From "A Manual of the Timbers of the World.")

embarrassment to the landowning class resulted during the war from the confusion between the names "silver spruce" and "silver fir."

The Structure of the Atom.[1]

By C. G. DARWIN.

II.—*Atomic Number (continued.)*

IT would involve very prolonged work to get the atomic numbers accurately by direct experiment with scattered α-particles. Fortunately, this is not necessary, as there exist much more convenient indirect means of determining them. The invention of a powerful method of studying X-ray spectra enabled Moseley to examine the spectra from a sequence of elements. Whereas visual spectra have a highly complicated structure, and exhibit the same periodicity as do chemical pro-

[1] Continued from p. 54.

perties, for the X-rays this periodicity disappears, and is replaced by a perfectly orderly progression from element to element. Each spectrum can be derived from the last by a reduction of the wave-lengths according to a simple rule. . Thus an examination of a sequence of spectra reveals the true order of the elements, and gaps are shown by a missing term in the sequence. It will be seen that Moseley's method only gives differences of atomic number, and not the numbers themselves. To determine these we must find one of them in some other way. This is not difficult, for we know from observation on α-particles that helium must have atomic number 2; and though X-rays have not been observed for the first dozen elements, the periodic table is perfectly regular in that region, and it is impossible to believe that it could contain any gaps. More remarkable still, if the formula for the wave-length of the X-ray spectrum is extrapolated right back to hydrogen, it reproduces the fundamental line of the famous Balmer series. The numbers which were given in the table are therefore certainly correct.

In formulating the principle of atomic number we said that it, and not the weight, completely determines the chemical character of the element. This statement is justified by a line of evidence which we must now consider. The process of radio-active transformation consists in the emission of an α- or a β-particle from the nucleus, and this emission transmutes the atom into a new element. From a study of the chemical behaviour of these successive elements it was concluded that the emission of an α-ray shifts the element two places to the left in the periodic table, while the emission of a β-ray shifts it one place to the right. This fits in exactly with the conception of atomic number, for when the nucleus loses an α-particle (that is, a helium nucleus of atomic number 2) its own number must be reduced by two, whereas the loss of a β-particle out of the nucleus must raise the number by one, since the β-particle is an electron and has a negative charge. By a study of all the radio-elements we can work out chains of transformations such as are shown in Fig. 1. These chains start at uranium 92 and thorium 90, and, so far as we know, all end at lead 82. It will be seen that most of the numbers are occupied several times over. For example, 90 has ionium, the parent of radium, as well as thorium and several others. It has been found that the spectra of ionium and thorium are exactly the same, and that all chemical methods are quite powerless to separate them from each other. They are chemically identical because they have the same atomic number, but they differ in the nature of their nuclei, as witnessed by the difference in their radio-active behaviour. Such substances are called *isotopes*.

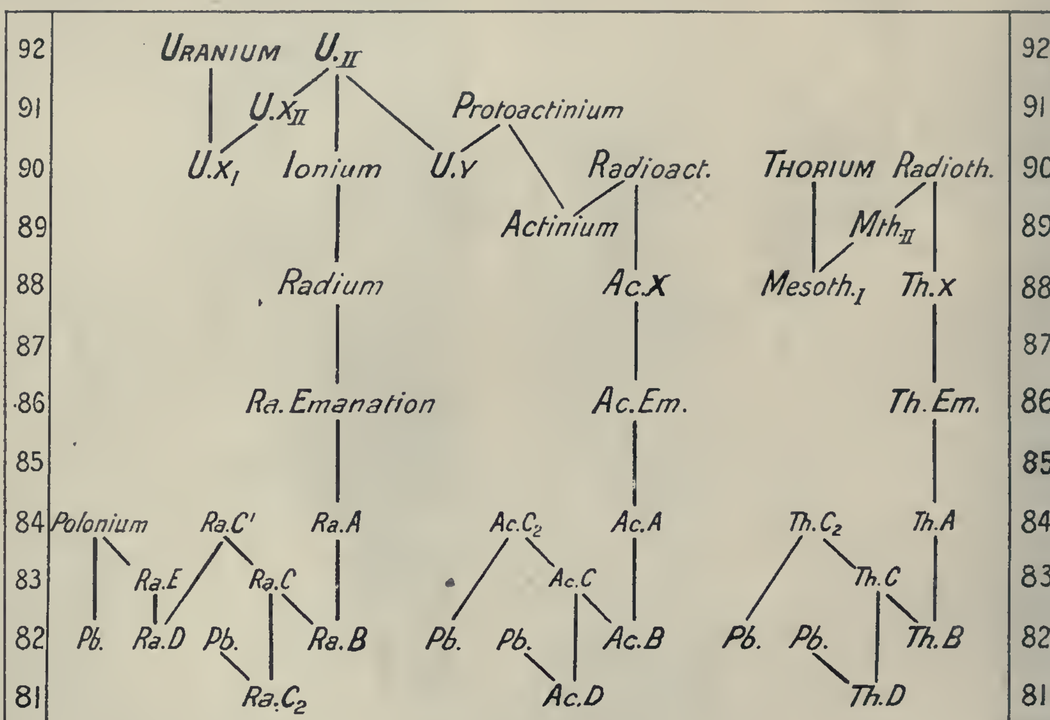

FIG. 1.—The Radio-active Transformations. In every case a step two downwards is accompanied by the emission of an α-particle, and one upwards by a β-particle. Actinium is derived from uranium or an isotope, but the connection shown is rather conjectural. Thorium C has a third branch about which little is known. The final products in all cases are believed to be lead, but as they are not radio-active it is uncertain how many of the isotopes are really different. In the Table of Atomic Numbers they were counted as all different, and one was added on to allow for the existence of common lead. One was also added there for 81 and 83 to represent the non-radio-active types of thallium and bismuth.

The existence of isotopes was first proved from radio-active evidence. But besides possessing the radio-active characteristics of the atom, the nucleus also carries its mass, and this suggests that isotopes may differ in mass. The first evidence for this can be derived from the study of the figure. For example, uranium at 92 loses an α-particle and two β-particles, and thus returns to 92; and the loss of the particles must have reduced its weight from 238 to 234. The same principle has been experimentally verified by finding that the atomic weight of lead from radium is perceptibly different from that of ordinary lead. We shall see in the next article that ordinary elements also have isotopes; for convenience, these have been given in the table, in so far as they have been yet discovered. It should perhaps be here mentioned that the mere difference of atomic weight theoretically implies certain minute differences in chemical behaviour, but it can be shown that these are out of all proportion less than those between substances of different atomic number, so much so that it is an almost impossibly laborious task to separate isotopes by ordinary chemical or physical processes.

The general outcome of our argument has therefore been that atomic number, and not atomic weight, is the determining factor in the behaviour of an element. There are exceptions to this rule—for example, specific heat depends directly on the weight of the atom—but apart from these exceptions the importance which in the past the chemist and spectroscopist have given to atomic weight must in the future be attached to atomic number.

(To be continued.)

Obituary.

PROF. WILHELM WUNDT.

WITH the death on September 1, at the advanced age of eighty-eight years, of Prof. W. Wundt a remarkable and striking personality passes away from the scientific world. If, as a philosophic thinker, he did not possess either the speculative genius or the insight of a Herbart or a Lotze, he was yet a mind of extraordinary versatility, whose comprehensive acquaintance with vast fields of knowledge has rarely, if ever, been rivalled. His amazing activity as a writer has been for long a source of wonder to his contemporaries; year after year books, pamphlets, and articles have issued from his pen in steady succession, and there was no department of philosophy which he thus left untouched. Naturally, this tremendous literary output is not all of equal worth, but almost everything he wrote exhibits a surprising mastery of detail and power of turning it to account in reaching theoretical conclusions. As a teacher, too, his influence has been extremely wide and far-reaching; students from all parts of the world met in his class-room, and worked in the Institute of Experimental Psychology at Leipzig, the foundation of which was due to him.

Wilhelm Wundt was born on August 16, 1832, at Neckarau, near Mannheim. In 1851 he began the study of medicine at Heidelberg, and in subsequent semesters pursued his medical studies further in Tübingen and Berlin. Fr. Arnold and E. Hasse, of both of whom he always spoke with great respect, were his teachers in Heidelberg; while in Berlin Johannes Müller was then at the height of his fame, and in the great man's laboratory Wundt was for some time busily engaged. On the completion of his career as an undergraduate, he turned his attention first of all to pathological anatomy, and took his degree in Heidelberg in 1886, his *Arbeit* being a thesis on the condition of the nerves in inflamed and degenerated organs. In the following year he habilitated in the Faculty of Physiology of the same university, and remained in Heidelberg for some years as Helmholtz's assistant in the physiological laboratory. During that period he published two monographs on physiological subjects—the "Beiträge zur Lehre von den Muskelbewegungen" (1858) and the "Beiträge zur Theorie der Sinneswahrnehmung" (1859–62)—in the long Introduction to the latter of which he first outlined his conception of the scope of empirical psychology as a natural science, and insisted upon the necessity of using experimental methods in the observation of mental processes. It was in consequence of his being occupied with the problems of sense-perception that the young physiologist was induced to enter the domain of metaphysical inquiry, and started to read, "ziemlich ziel- und planlos," as he tells us, the works of Kant, Herbart, and Leibniz. The first fruits of these and of his more strictly psychological labours saw the light in the "Vorlesungen über Menschen- und Thierseele" of 1863—a volume in which, as he afterwards expressed it, he set about his task with more zeal than discretion, and which he came to look upon as containing the wild oats of his youthful days. There followed in 1865 a text-book of "Human Physiology" (which apparently had a large circulation, a fourth edition appearing in 1878), and in 1867, when he was already a professor in Heidelberg, a voluminous treatise on what he called "Medicinische Physik," intended to acquaint medical students with the exact physical methods needful in medical investigation. Probably the most elaborate piece of experimental research undertaken by himself was that of which account is given in his "Untersuchungen zur Mechanik der Nerven und Nervencentren," the first part of which was published in 1871 and the second in 1876. The bold and ingenious hypothesis, which he here put forward, of reflex phenomena has not been sustained by later investigation, but it was a resolute effort to explain a large group of facts of which an adequate theory is still to be sought, and it led incidentally to not a few interesting observations, some of which are referred to by Sherrington in his book on the nervous system.

Wundt succeeded F. A. Lange as professor of "Inductive Philosophy" in Zürich in 1874. In the same year the "Grundzüge der physiologischen Psychologie" was published in two volumes (increased to three volumes of huge proportions in the fifth edition of 1902). His sojourn in Zürich, however, was of short duration. In 1875 he removed to Leipzig, on his appointment to one of the philosophical chairs in the university; and, despite several attempts on the part of other centres of learning to draw him away, Leipzig continued to be his home for the last forty-five years of his life.

In his "Antrittsreden" of 1874 and 1876 Wundt sketched the view which, as professor in Leipzig, he consistently maintained of the function of philosophy, and of the influence which philosophy, as he conceived it, should exert upon the empirical sciences. Philosophy, he contended, is based upon the results reached by the empirical sciences, and forms their necessary supplement and completion. It has for its main purpose to consolidate into a coherent system the generalisations of the special sciences and to trace back to their ultimate grounds the principles and presuppositions which the special sciences are compelled to use. But, he insisted, if philosophy is dependent for its material upon the special sciences, the latter are no less dependent upon philosophy for a justification of the fundamental concepts without which scientific explanation would be impossible. And great as had been the influence of Kant, Hegel, and even Schopenhauer upon the science of their time, he foresaw that the influence of exact philosophical thought upon the science of the future would be greater and more significant still. From this point of view it was natural that, as a philosophical inquirer, his attention should be directed at the outset to the problems of knowledge. His "Logik," the first volume of which was devoted to "Erkenntnislehre," was published in 1880, and the second, dealing with the methods of scientific investigation, in 1883 (in later editions the "Methodenlehre" expanded into two volumes), is undoubtedly a work of considerable importance, and may justly be said to occupy a distinct place in the history of logical science. In the first volume the author tries to steer a middle course between the purely formal view of logic on the one hand and the metaphysical view of it on the other, while in the second volume he undertakes by far the most accurate and detailed examination in existence of the principles, methods, and results of the special sciences. The study of logic in this country has suffered much through want of an English translation of a book which in its way is unique. The next of Wundt's larger works to be published was the "Ethik" (1886)—an investigation, as he described it, of the facts and laws of the moral life. Although not, I think, on the same level of value as the "Logik," it is a suggestive and stimulating treatise, basing an ethical system upon the doctrine of evolution, which here takes form for him especially in the ideas of human progress and of the "Gesamtwille." Finally, as the culmination of his attempt at philosophical construction, the "System der Philosophie" appeared in 1889, in many respects the most original of all his writings, and that by which his position in the development of philosophical thought is most definitely established.

The position is not one that can be indicated in a few words. Wundt took his departure from the point of view of what he called "immediate experience"—experience as he conceived it would be prior to the elaboration of it by reflective thought, which is itself evolved from it. The data of such primordial experience might be classified under the three heads of presentations, affective processes, and conative activities. Originally, presentations are, he insisted, for the experiencing subject not different from objects; they are *Vorstellungsobjecte,* wholes which contain the elements, as yet undifferentiated, which thought in the course of time distinguishes. The development of thought means that presentations come to be separated from the objects to which they are taken to refer; and, when the attempt is further made to conceive these objects as freed from contradiction, they have to be represented as destitute of such attributes as sense-qualities, which, as intuitively experienced, must belong to the subject. The world of physical science is, therefore, wholly conceptual in character; for physical science the ultimate constituents of objects are material points. On the other hand, a psychological treatment of the subjective factors leads to the notion of activity and passivity as mutually involved in every mental state. But we are compelled to conceive of activity as that which is essentially characteristic of our conscious being and to ascribe the passivity we experience to the objects which affect us and thereby counteract our activity. The pure activity which he thus took to be characteristic of the subject Wundt designated will; will he regarded as the essence of subjective existence. Ontologically, however, there was no stopping short of a monistic view of the universe. In the long run the concept of object rests upon an effect which the will experiences, and what thus limits the will is not in itself immediately known. We can only conclude, on the basis of our own experience, that what occasions passivity must in itself be active; and, since will is the only activity known to us, we are justified in ascribing our passivity to another will. Presentations, then, are to be traced back to the reciprocal action of different wills. A further step brought the author to his final contention. Our personal individual wills are not, he argued, elementary will-units, but units of a higher order comprising many elementary will-units. And these units of higher order may be thought of as in turn uniting to form higher unities still (*e.g.* the collective will of society), until in the end we reach the thought of a world-will including within itself the multiplicity of individual wills.

Many of Wundt's psychological theories—such, for example, as his well-known doctrine of apperception—only become intelligible in the light of his general view of Nature. Emphatic as he was in claiming for psychology a position of its own as an empirical science, he never ceased to regard it as standing in the closest and most intimate relation with philosophy. Even in the "Grundzüge," which is a storehouse of facts largely accumulated in his own laboratory, he turns again and again to the discussion of problems essentially philosophical in character. That work has often been severely criticised, yet when all is said it remains one of the great and permanent contributions to the modern science. The Leipzig Institute was started in a humble way in 1878, but it grew by rapid strides, and Wundt lived to see one of his early desires realised—namely, that the time would come when in every German university a psychological laboratory would be deemed a part of the necessary equipment. The "Philosophische Studien," of which he was the editor, served as a medium of publication for the work of his pupils, and many valuable articles of his own are likewise contained in the twenty volumes that appeared from 1883 to 1903. The last years of his life saw also the realisation of another of his early dreams. In 1900 the first volume of his "Völkerpsychologie" was published, and five other bulky volumes followed. Here, again, to some extent he was breaking new ground, where, however, he was entirely dependent for his material upon the labours of others.

Wundt married shortly after leaving Heidelberg; his son is distinguished as an authority in Greek philosophy, and to his daughter, his companion "im Urwald der Mythen und Märchen," one of the volumes of the "Völkerpsychologie" is dedicated. In private life he was a man of many lovable qualities. His old students look back to many delightful hours spent with him in the midst of his family, and remember with gratitude his kindly interest in them and their work. Slender in build, never of strong physique, and troubled with failing eyesight, it seems well-nigh incredible that he got through the multitudinous labours of which I have spoken, and survived so many of his former pupils. He was wonderfully effective as a lecturer; without a note, and usually to audiences of more than three hundred students, he would handle in a concise and lucid manner themes of notorious difficulty. Absorbed in his scientific pursuits, allowing himself little leisure, but content and happy in his modest and simple home, his life was a rounded whole, the memory of which one would not willingly let die.

G. Dawes Hicks.

Armand Gautier.

By the death of Emile Justin Armand Gautier, at Cannes, in his eighty-third year, France loses one of her most distinguished chemists. Born at Montpellier, the son of a medical man, Gautier appears to have been destined to follow his father's profession, and to his early training is to be attributed, in all probability, the direction of much of his subsequent life's work in science, notably in biological chemistry. As a youth he obtained a post, under the Faculty of Montpellier, first as *aide-préparateur* and then as *préparateur* in the chemical laboratory, where he remained five years, and where he acquired that power and facility of manipulation which characterised his experimental work. In the early 'sixties he seems definitely to have decided to attach himself to chemistry as a career. At that period the science was experiencing profound changes, and chemical theory was developing with remarkable rapidity, more particularly owing to the progress in organic chemistry. Wurtz was everywhere recognised as one of the pioneers and leaders of the new movement, and accordingly young Gautier repaired to Paris to work under his inspiration and direction. At Paris he remained, becoming, in 1869, a member of the Faculty of Medicine, in 1872 director of the first laboratory of biological chemistry instituted in France, and in 1884, on the death of Wurtz, professor of medical chemistry. He was elected a member of the Academy in 1889.

During the fifty years of his scientific activity Armand Gautier published an extraordinary number of memoirs—upwards of 600, it is said. They range over every department of the science and practically every sub-section of it. Many of them, of course, are not of first-rate importance, but, collectively, they serve to show his breadth of sympathy, his receptivity, his intellectual keenness, his versatility, and the many-sidedness of his interests.

Here we can deal only with his more noteworthy contributions to the literature of chemistry. The influence of Wurtz is stamped on the earliest of them—as in his work on cyanogen derivatives, on the nitriles and their isomerides, the carbylamines—which mostly appeared in the Bulletin of the French Chemical Society and served to establish Gautier's position as one of the foremost investigators of the new French school. His appointment as director of the laboratory of biological chemistry, already referred to, gave a fresh impetus and a new departure to his work as an investigator. In 1872 he signalised the existence of a class of cadaveric alkaloids, termed by Selmi *ptomaines,* and presumed to be products of putrefaction. Earlier investigators, such as Panum, Dupré and Bence Jones, Marquardt, Schmidt, Bergmann and Schmiedeberg, Zuelzer and Sonnenschein, had obtained so-called putrefaction bases which occasioned physiological effects similar to certain vegeto-alkaloids. Selmi's term was adopted by Gautier to denote alkaloidal substances formed in the putrefaction of proteins. The earlier literature relating to the ptomaines—a term now fallen into disuse in scientific nomenclature—is full of errors, and there is practically no evidence that what is called "ptomaine poisoning" is due to poisonous alkaloids: it is rather to be attributed to bacterial infection and is caused by bacterial toxins. Gautier found in fresh tissues a number of basic substances, related to uric acid and creatinine, which he regarded as the products of ordinary metabolism, and to which he gave the name of *leucomaines*, to distinguish them from the products of bacterial action.

A subject which engaged Gautier's attention for some time, and to which he occasionally returned, was the widespread diffusion of arsenic in the animal organism, which led to work on improved methods of detecting and estimating that element in micro-chemical quantities. His speculations concerning the *rôle* played by arsenic, as well as by iodine, in our organism may be said to be at the basis of modern therapeutics. The question of the influence of the infinitely little on hygiene had, in fact, a special attraction for him. It is seen in his work on the action of the impurities of the air of towns on the public health. He detected the constant presence in air of iodine, as well as of hydrogen; the former, he imagined, was due to the presence of microscopic algæ, the latter to emanations from primitive rocks, volcanoes, and thermal springs.

Gautier, as a biochemist, also engaged himself in questions of plant physiology and on the chemical transformations of various products in the life-history of vegetable organisms. These studies occasionally took a practical turn, as, for example, in his inquiries into the colouring matter of the grape and the detection of the fraudulent colouring and dilution of wine, and into the influence of "plastering," "collage," and fortifying on the weight of the dry extract. The nature of tobacco-smoke also attracted his attention. He found that when tobacco is smoked in a pipe the volatile liquid products consist mainly of basic compounds, among them nicotine, a higher homologue, $C_{11}H_{16}N_2$, which pre-exists in tobacco leaf, and a base, C_6H_9NO, which appears to be related to picoline. Hydropyridines and other alkaloids are also present, resulting from the decomposition at relatively low temperatures of the carbopyridic and carbohydropyridic acids present in the leaf.

Gautier was a fellow-worker with Maxwell Simpson in Wurtz's laboratory, and the two collaborated in the study of the action of hydrocyanic acid upon aldehyde. He was an occasional visitor to this country, and represented France at various academic gatherings in London. He was a genial soul, and, as was said of him by M. Deslandres, president of the Academy of Sciences, when pronouncing his *éloge*, remained young in spirit and young of heart until the end.

T. E. THORPE.

BY the death of MR. HENRY BASSETT, F.I.C., at the age of eighty-three, on August 30, we have lost one of the few remaining survivors of that ardent band of young chemists who studied under Dr. A. W. Hofmann at the Royal College of Chemistry. Handicapped at the start by the death of his father when he was only nine years old, Mr. Bassett had an uphill fight all his life; but he was animated by the same spirit which often enables the poet and the artist to produce good work under most unfavourable conditions. For a time he acted as assistant to Brodie at Oxford, but most of the best years of his life were taken up in testing anthracene as assistant to Mr. F. A. Manning. In 1894, at an age when men more fortunately situated are thinking of retiring, he started a consulting practice of his own, first at St. Andrew's Hill and then at 104 Queen Victoria Street, specialising in non-ferrous alloy and anthracene work. Never lacking in ideas, Mr. Bassett always had some research work in hand, and at intervals, from 1863, he published some seventeen papers and short notes, mainly in the Journal of the Chemical Society or the *Chemical News*. Several of these had reference to anthracene testing, into which he introduced some improvements, and on which he was a recognised authority. His most important research was certainly that on ethyl orthocarbonate, which he prepared by the action of sodium on a mixture of chloropicrin and absolute alcohol. This was published in the Journal of the Chemical Society for 1864, and may give him a permanent place in chemical literature. Several short papers on chlorides of carbon and one on eulyte and dyslyte may also be mentioned. During the course of his consulting practice Mr. Bassett carried out a considerable amount of research work, notably on the corrosion of manganese and other bronzes by sea water, which was never intended for publication. Of recent years he had been doing some very interesting work on graphite, and until within a fortnight of his death had been trying to get his results into a form suitable for publication.

WE regret to note that the death of Mr. ISHAM RANDOLPH on August 2, at seventy-two years of age, is announced in the *Engineer* for September 10. Mr. Randolph's most prominent work was on the Chicago drainage canal, of which he was chief engineer from 1893 until 1907, and was thereafter its consulting engineer until 1912; this great work cost about 12,000,000*l*., and has a hydro-electric plant of 40,000 h.p. He was a member of the international board of consulting engineers for the Panama Canal, and occupied many other important public posts. Mr. Randolph was a member of many engineering societies, including the American Society of Civil Engineers. The Franklin Institute awarded him the Elliott Cresson Medal for distinguished achievements in civil engineering, and the University of Illinois conferred upon him the degree of Doctor of Engineering in 1910.

Notes.

THE earthquake felt on September 7 in the north of Tuscany proves to have been much more serious than the early accounts indicated. Many towns and villages are completely destroyed. The epicentre seems to have been near Fivizzano, a small town, now a heap of ruins, on the slope of the Apennines, and about twelve miles north of Carrara. The area within which buildings were damaged is evidently extensive, as it includes both Viareggio and Pistoia, the latter town being about forty-five miles south-east of Fivizzano. The number of deaths so far reported is 327, but the real number is probably much higher. The earthquake appears to be the most violent known in this part of Italy, which is fortunate in possessing a meagre seismic history. On April 11, 1837, an earthquake, with its centre about five miles south-east of Fivizzano, caused some damage in that town. On September 10, 1878, a strong shock, with its centre close to Fivizzano, again injured a few houses there. Indeed, the recent wholesale destruction of villages is evidence of their long immunity from violent earthquakes, for the buildings were not of that resisting type the construction of which is now enforced in the rebuilt towns of Italy.

IN the detailed exploration of the coasts of Greenland Danish explorers have taken a leading part. Plans of a new expedition under the leadership of Mr. Lauge Koch have been sent to us by Dr. M. P. Porsild, of the Danish Arctic Station in Disko, Greenland. In order to commemorate the voyage of Hans Egede to Greenland in 1721, which began the systematic settlement of the west coast by Denmark, Mr. Koch's expedition is known as the Bicentenary Expedition to the North of Greenland. The Danish Government has provided a vessel and part of the funds, the remainder of the cost being met by subscription in Denmark. The expedition left Copenhagen on July 15 for Robertson Bay in Inglefield Gulf, where a wintering station is to be established. From there a depôt is to be laid in Warming's Land. It is hoped that this will be done in the late summer with the help of motor-tractors. The journey to the depôt will be repeated next year with dog-sledges, and the main work of the expedition will then begin. This includes journeys to the interior of Peary Land and to the north of Adam Biering's Land, where an advanced base will be established. Independence Fjord, Böggild's Fjord, and the unknown parts of Wulff's Land and Warming's Land will be mapped. In the following spring the expedition will travel along the coast from its winter quarters through Kennedy and Robson Channels, round the north of Peary Land into Independence Fjord. The return journey will be made by the main depôt to Robertson Bay. Mr. Koch is accompanied by Mr. C. F. Slott and several Eskimo.

THE *British Medical Journal* for September 11 announces that the International Society of Surgery, at its recent meeting in Paris, elected Sir William Macewen, of Glasgow, as its president for the next congress, to be held in Great Britain—probably in London—during the summer of 1923.

THE British Launderers' Research Association has been approved by the Department of Scientific and Industrial Research as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. The secretary of this association is Mr. J. J. Stark, 162–65 Bank Chambers, 329 High Holborn, W.C.1.

THE Royal Academy of Science of Turin has sent us a leaflet announcing the offer of two Bressa prizes of 9000 lire for the greatest work in almost any branch of science during the past four years. Candidates may submit printed (not written or typed) works to the Secretary before December 31, 1922. Members of the Turin Academy are not eligible to compete for the prizes.

THE eighth annual Indian Science Congress will be held in Calcutta from January 31 to February 5, 1921. His Excellency the Right Hon. the Earl of Ronaldshay has consented to be patron of the meeting, and Sir R. N. Mukerjee will be president. Members intending to read papers should send them, together with a short abstract, to Mr. P. S. MacMahon, Canning College, Lucknow, before November 30.

THE Secretary for Scotland has appointed an Advisory Committee to advise him on matters connected with the administration of the Wild Birds Protection Acts. The Committee consists of Mr. Hugh S. Gladstone (chairman), Dr. W. Eagle Clarke, Dr. Walter E. Collinge, Mr. H. M. Conacher (representing the Board of Agriculture for Scotland), Mr. H. J. Crowe (representing the Fishery Board for Scotland), and Prof. J. Arthur Thomson.

THE widespread, popular belief in the use and value of the divining rod gives considerable interest to a recent publication of the United States Geological Survey on the subject. "The Divining Rod," by Mr. A. J. Ellis (Water-supply Paper 416), is a condensed history of water-witching, to which is added a bibliography with many hundred entries. The origin of the divining rod is lost in antiquity, but a belief in its value for a variety of purposes besides water-finding has persisted until the present day. The U.S. Geological Survey considers that for all practical purposes the matter is thoroughly discredited and of no value whatever in locating either water or mineral ores. Mr. Ellis adds a note on various mechanical "water-finders," most of which are magnetic or electrical instruments. He dismisses the claims of all these contrivances as being purely speculative and quite unsound in principle.

THE *Geographical Journal* for July (vol. xvi., No. 1) gives a summary by Dr. Hamilton Rice of his recent expedition to the headwaters of the Orinoco. Dr. Rice's route was from the Amazon up the Rio Negro to the Orinoco. Esmeralda was reached at the end of last year. The Orinoco was then ascended to the rapids of Guaharibos, where Dr. Rice's party of ten was attacked by a big band of Guaharibos and compelled to fight. Material has been obtained for a map traverse on a scale of 1 : 125,000 of the route from Manáos to the Guaharibos rapids. The traverse is checked by more than forty astronomical stations, where time was obtained by field wireless from Darien and Washington. Magnetic observations were taken at more than twenty of the stations. Meteorological readings were taken four times daily in conjunction with similar readings at the same hours at Para. Much attention was paid to geological research. Finally, Dr. Rice says that the survey of the diseases encountered will form one of the not least valuable results of the expedition.

THE problem of suitable maps for aviators continues to attract much attention and is far from being satisfactorily solved. In the *Geographical Journal* for August (vol. lvi., No. 2) Capt. H. A. Lloyd has a short paper, illustrated by many admirable photographs, on the classification of the ground from the air. Experience on the Western front during the war convinced Capt. Lloyd that the whole area could be divided into distinctive zones differentiated by the shapes of fields or by the industries carried on in particular localities. A recognition of these types of terrain was found to enable a pilot to determine his approximate position. This was particularly valuable in the case of a pilot losing his way owing to clouds or in flight over the country for the first time. Thirteen types of ground were recognised and taught to pilots in the area of the Western front between the sea and the River Oise. Under war conditions this classification had its limitations because the destructive effect of battle, as a rule, removed all features visible to the eye and generally to the camera. It is also noted that, under normal conditions, while the shape of the fields and other features remain constant, the height of the vegetation affects the appearance of the photograph. Thus a field of ripe corn may look almost as dark as a row of trees. These seasonal variations would need to be taken into account in making use of such a classification in map-construction. Capt. Lloyd also discusses the classification of landmarks, and insists that small-scale maps, such as are used in flying, should portray the chief features of towns so that a glimpse of a town would be enough for an aviator to locate his position. These considerations entail the omission of much of the detail shown on maps for land use, so that the features conspicuous from the air may stand out boldly.

A PROSTRATE variety of potato has been found in the breeding experiments of Messrs. R. N. Salaman and J. W. Lesley (*Journal of Genetics*, vol. x., No. 1), which, it is suggested, may be useful for potato-growers in semi-arid climates, since the foliage, lying on the ground, has a considerable effect in conserving the soil moisture. This variety breeds true, and is shown to differ from the upright type in a failure to form secondary xylem in the stem. A procumbent variety, the stems of which turn up at the end, has also appeared. Anatomically, it agrees with the prostrate variety. In both these types the crop of tubers is unaffected.

IN an interesting further study of melanism in moths, Mr. J. W. H. Harrison (*Journal of Genetics*, vol. x., No. 1) discusses crossing experiments with *Tephrosia bistortata*, *T. crepuscularia*, and their melanic varieties. The melanic variety of *T. crepuscularia* behaves as a simple Mendelian dominant to the type, and the same has been shown to be true of various other melanic varieties. But in crosses of *T. bistortata* with the melanic form of the other species a great range of colour forms was obtained in F_1 and F_2, with no indication of Mendelian segregation. The results are interpreted as showing that the unit factor for melanism has been modified, and in some cases broken up so that it has practically disappeared.

As a first study of inheritance of egg-weight in fowls, Philip Hadley and Dorothy Caldwell (Bull. 181, Rhode Island Agr. Expt. Station) make an analysis of the normal distribution of egg-weight in White Plymouth Rocks. Egg records from a flock of thirty-nine hens through eight years showed that individual hens differed markedly in the weight of eggs laid in any period. The first eggs of any year are smaller, increasing to a maximum in April, then falling to a minimum in July or August, followed by another maximum and minimum in September and November respectively. After the second laying year these maxima appear less clearly, and after the fourth there is a progressive decrease in the weight of eggs produced each year. There appears to be a slight tendency for heavier hens to lay larger eggs.

THE attention of workers on Diptera is directed to Mr. E. Brunetti's catalogue of Oriental and South Asiatic Nemocera, which has been published as vol. xvii. (300 pp., June, 1920) of the Records of the Indian Museum. Mr. Brunetti states that he has included in his catalogue all the names of species available up to the middle of 1919. In nomenclature his policy has been to retain the names employed by the principal dipterologists of the last century; he believes in "continuity before priority," and does not agree with the general overturning of generic and specific names, suggested by strict priorists, which arises out of the much discussed "1800 paper" of Meigen. For each species the author gives the essential bibliographical references and synonyms, and indicates the distribution. The location of the type-specimen, where this is known, is stated. The Culicidæ (mosquitoes) receive careful consideration, and the list of these extends over ninety-six pages of the catalogue.

IN view of the present scarcity in the supply of cotton, the attempts now being made to establish cotton-growing on a large scale in Mesopotamia are of particular interest. Cotton has been grown in Mesopotamia from very ancient times, and is still cultivated in small quantities by the Arabs in conjunction with food-crops along the banks of both the Tigris and Euphrates. The fibre is used locally for spinning and as a stuffing material for pillows and mattresses. The country possesses a soil and climate favourable to the production of large yields of excellent cotton, and in course of time it should add materially to the world's supply. Since 1917 experiments have been conducted by an expert from the Indian Agricultural Service with the view of discovering the most suitable kinds to grow, and the results of the work done in this connection and the prospects of establishing a cotton-growing industry are fully dealt with in the current number of the Bulletin of the Imperial Institute. So far, American types of cotton seem to be the most suitable for cultivation in Mesopotamia. The members of a deputation of the British Cotton Growing Association which visited the country towards the end of last year were very favourably impressed with its possibilities for cotton production.

THE July-August issue of the *Scottish Naturalist* (Nos. 103 and 104, pp. 99–144) is devoted to a report on Scottish ornithology in 1919 by Miss Leonora Jeffrey Rintoul and Miss Evelyn V. Baxter—a careful piece of work in which many contributors have assisted. The most interesting feature of 1919 is the extension of the breeding range of certain species. Of these the most important is the reappearance of the Whooper swan as a Scottish breeding species. Migration ran a fairly normal course; the cold spring seemed to have no effect on the arrivals of summer visitors. A very large movement took place in the first half of May, but no very big migrations are recorded in autumn, the only one of any magnitude being a weather movement in mid-November caused by the very hard frost and snow at that time. No new birds were added to the Scottish list, but a good many uncommon visitors and new records for particular faunal areas are noted, *e.g.* a blue-headed wagtail at Fair Isle, a red-backed shrike in Moray, two reed-warblers from Lerwick, a bee-eater at Lentran, two American widgeon from Tay and Clyde, and a spotted crake from Ross-shire. The garden-warbler and the pied flycatcher were both found nesting in the Moray area. The report deals also with the decrease of certain species in various areas, with varieties of plumage, with the noteworthy phenomena of the various seasons, and with peculiarities of habit, such as carrion-crows acting as foster-parents. It is cheering to read that on October 5, at Swordale, East Ross, a golden eagle, two buzzards, and a peregrine falcon were all seen in the air together. The authors are to be congratulated on the continuation of their valuable series of annual reports.

IN Professional Paper 98–L of the U.S. Geological Survey, Messrs. G. C. Matson and E. W. Berry provide the first description of a North American Pliocene flora. This comes from the Citronelle formation of the Gulf coastal plain, extending from western Florida to eastern Texas, and indicates climatic conditions in late Pliocene time similar to those of the present day. The modern forest flora is well illustrated in its habit as it lives, to furnish a picture of the Pliocene period.

MR JOHN PARKINSON introduces the term "lak" into geography in his "Report on the Geology and Geography of the Northern Part of the East Africa Protectorate" (Colonial Reports—Miscellaneous, No. 91, 1920). A lak is a drainage-channel that may carry water periodically; it is often a guide to the capacity of an area for development. On the banks of some laks in East Africa the abundance of molluscan shells indicates the former existence of extensive lakes, and the water-supply found in the wells may be a relic of these lakes in a region that has clearly suffered from desiccation.

DRUMLINS, kames, and eskers play a large part in the topography of northern temperate lands in Europe and America, and their relations are well illustrated in maps and landscapes in Mr. W. C. Alden's important memoir on "The Quaternary Geology of South-eastern Wisconsin" (U.S. Geol. Surv., Prof. Paper 106, 1918). The distribution of the drumlins of the Green Bay glacier west of Lake Michigan, and of the subglacial eskers, is a very striking feature of the large "surficial" map. Would the U.S. Survey consider the folding of its maps with the printed side outwards, as is done by the Ordnance Survey of the British Isles, following the plan adopted by so many travellers in their field-work?

A CATALOGUE of the Mesozoic and Cenozoic Plants of North America, by F. H. Knowlton, has been issued as Bulletin 696 of the United States Geological Survey. It contains 815 pages, and should form a useful work of reference. The catalogue is an alphabetically arranged list of the genera and species that have been described. For each American form that is known only in a fossil state the original date and place of publication are given; then follow all or the most important references, especially such as refer to descriptions and figures. For each Old World form that is recognised in North American strata the original date and place of publication are given; a reference to the publication in which the form is first recorded as American follows, and then in chronological order the American references. For living species found fossil only the authority is given, followed by the first reference to the species in a fossil state, and then by other important references. The synonymy is placed under the species to which it belongs, but each synonym occurs in its proper alphabetical place with a reference to the form to which it is now referred. The catalogue is supplemented by a systematic arrangement of the genera and an index of genera and families. There are also a list of the North American Mesozoic and Cenozoic plant-bearing formations, with the plants found in each alphabetically arranged, and a bibliography.

THE Report issued by the United States Geological Survey of the world's production of copper in 1917 has recently been published. For many years the U.S.A. has been the largest producer of this metal. In 1913 its production was about 57 per cent. of the world's output of just under one million tons. During the war there was a greatly increased use of this metal, and the demand of the belligerent countries was satisfied principally by a very large increase in American production. The high-water mark was reached in 1917, when a grand total of 1·454 million tons was extracted. Of this the U.S.A. produced 0·855 million tons. Japan and Chile also increased their smelter production to a little more than 100,000 tons. Then follow Canada, Mexico, and Peru. It will be seen, therefore, that by far the greater part of the world's copper was derived from the western hemisphere. It is evident that the U.S.A. is the largest single factor in nearly every phase of the industry. At present it is not only much the largest producer and consumer, but it also excels in both imports and exports. At the beginning of 1917 the producing capacity was the largest in the history of the industry, and was almost wholly utilised. The principal producing State was Arizona, followed by Montana, Michigan, and Utah. These four States provided 79 per cent. of the total American output in 1917.

MR. T. SHEPPARD, whose careful record of William Smith's maps and memoirs has just been published by Messrs. Brown and Sons of Hull, chose "The Evolution of Topographical and Geological Maps" as the subject of his address to the Delegates of Corresponding Societies at the British Association meeting in Cardiff. He showed how incomplete our collections are of county maps, while such publications are occasionally used by dealers for the wrapping of book-parcels. Great credit is very properly assigned to John Cary's work in England from 1787 to 1832; his large road-map, with the coach-roads coloured in blue, is on the scale of five miles to one inch, not ten as stated, and, with its index of every village, is still of great value in a private library. In citing maps published after the initiation of the Ordnance Survey, those of Scotland by Faden and Wyld, on the basis of surveys by General Roy and John Ainslie (1839), and by Arrowsmith, scale four miles to one inch (1840), used as the basis of MacCulloch's fine geological map, are worthy of mention. MacCulloch seems to have completed his share in this map in 1834. The second and most authoritative edition of Griffith's map of Ireland was issued in 1855, not 1853, as given in the address. Attention is well directed to the "soil-maps," in reality precursors of our "drift-maps," published in connection with agricultural and statistical surveys about the beginning of the nineteenth century. That of Londonderry by Sampson in 1802, with its blue boulder-clay and pink sands and gravels, interestingly anticipates our modern colouring. Mr. Sheppard's address as now printed is a welcome work of reference.

MONTHLY results of magnetical, meteorological, and seismological observations at the Royal Alfred Observatory, Mauritius, to April, 1920, have been received. Hourly observations of the magnetic declination, horizontal force, and vertical force are given from the photographic records. There are similar observations for each hour of atmospheric pressure, direction and velocity of wind, temperature of the air and evaporation, amount of cloud, duration of bright sunshine, and rainfall, most of which are from self-registering instruments. Monthly rainfall totals are given for about 100 stations in Mauritius, grouped according to the river systems. The monthly and yearly means and extremes of the meteorological elements at the Royal Alfred Observatory for 1919 are tabulated. July had the highest mean atmospheric pressure, and February and March the lowest. The absolute highest temperature was 34·9° C. in January, and the lowest night minimum 13·0° C. in August. The mean of the daily maxima was highest, 32·1° C., in January, and lowest, 23·4° C., in July. The mean of the night minima was lowest, 16·3° C., in August, and highest, 23·3° C., in February. The degree of humidity, saturation 100, was highest, 78, in March, and lowest, 69, in November. The amount of rain was greatest, 202·7 mm., in March, and least, 24·3 mm., in May, the total for the year being 1001·6 mm.

"NOTES on the Ground Day Visibility at Cranwell, Lincolnshire," by Capt. W. H. Pick, published by the Meteorological Office as Professional Notes No. 11, is an attempt to find the relations existing between visibility and wind direction, wind velocity, and distribution of pressure. The period dealt with is from February 1 to April 8, 1920, and for hourly observations from 9h. to 17h. G.M.T. It is shown that winds in the south-west quadrant brought the best visibility, winds between west and east through north a considerably lower degree, and winds in the south-east quadrant the lowest degree. It is pointed out that visibility with winds greater than 12 m.p.h. was much higher than it was with winds less than or equal to 12 m.p.h. Classification according to pressure distribution shows that the mean visibility in front of a depression is 5·1 of visibility-scale (0–9), in the rear of a depression 5·0, and in a secondary depression 4·9. In an anticyclone or wedge it is 3·9 of scale, in a col 4·7, and with straight isobars south to north 3·2, west to east and south-west to north-east 5·5. The period of observation discussed—sixty-eight days of nine consecutive hours each—is far too short. The situation of Cranwell and its proximity to hills would render the conditions found quite different from those in many other parts of the British Isles, or on the open sea contiguous to our coasts. The relations between visibility and pressure distribution seem open to doubt. No attempt has been made to ascertain the relation of visibility to time of day.

THE August issue of the Journal of the Society of Glass Technology contains the paper on the properties of the raw fireclays found in this country which was communicated to the meeting of the society in April by Miss E. M. Firth, Mr. F. W. Hodkin, and Dr. W. E. S. Turner. Twenty-seven clays were examined, only five of them falling within the specification of the Refractories Research Committee of the society as suitable for glass-furnaces. The results show no correlation between the physical properties and chemical compositions of the clays, and the authors conclude that the classification of clays according to chemical composition is premature, and should be replaced by one according to their shrinkage and porosity. Most of the clays tested show expansion at some part of the firing range, owing probably to the allotropic changes in the silica present. In general, clays with high alumina content show a wide range of porosity, but there are notable exceptions. From the tables of the properties of the various clays given by the authors it is possible to calculate the properties of a mixture of them when fired to a given temperature.

CONTINUING his researches on the alloys of iron with chromium and tungsten, Prof. Honda has recently published in the Science Reports of the Tôhoku Imperial University an investigation on the structural constitution of high-speed steels containing these elements. He concludes that in an annealed steel containing 5 per cent. of chromium, 18 per cent. of tungsten, and 0·6 per cent. of carbon the alloy consists of a solution of iron tungstide in iron, together with free tungstide and the carbides Cr_4C and WC. On heating such a steel above Ac_1 the carbides dissolve, and the chromium carbide Cr_4C is converted into Cr_3C_2 and metallic chromium. The higher the temperature, the more the change proceeds in this direction. On cooling, the reverse change takes place only slightly, and the result is that at the ordinary temperature a steel is produced containing the carbides, chromium, and the tungstide all in solid solution. This, according to him, is the constitution of the hardened steel. The self-hardening property is conveniently studied by the temperatures of the transformations, while the degree of tempering on later heating is best studied by means of magnetic heating curves. The tempering takes place in two steps—one at about 400° and the other above 700°. Prof. Honda concludes that self-hardening and resistance to tempering depend primarily on the quantity of Cr_3C_2 dissolved in iron containing chromium and tungstide. These properties increase both with chromium and carbon and with rise of temperature. The function of tungsten appears to consist in lowering the temperature, at which self-hardening begins to be manifest. When this element exceeds 12 per cent. it exists as fine globules of tungstide Fe_2W, and these are directly related to the cutting efficiency of the tool.

WE have just received from W. Heffer and Sons, Ltd., of Cambridge, a catalogue of their library of second-hand books. Science and mathematics are well represented by a number of the bigger text-books, and several collections of bound volumes of scientific journals are also offered for sale.

THROUGH the omission of the word "hundred" from line 28 of the first column of page 38 of last week's NATURE, the annual production of coal in Great Britain was erroneously stated to approach "three million" instead of "three hundred million" tons. It is shown in the article upon the proceedings of the Section of Economics and Statistics of the British Association, printed elsewhere in this issue, that the output in 1913 was 287,000,000 tons.

Our Astronomical Column.

TEMPEL'S COMET.—This comet is now fading, but may still be visible for some weeks. The following ephemeris, for Greenwich midnight, is by M. Ebell:

	R.A. h. m. s.	S. Decl. ° ′		R.A. h. m. s.	S. Decl. ° ′
Sept. 17 ...	3 1 5	8 27	Oct. 3 ...	2 51 44	10 53
21 ...	2 59 45	9 8	7 ...	2 47 59	11 21
25 ...	2 57 42	9 46	11 ...	2 43 50	11 44
29 ...	2 55 0	10 22	15 ...	2 39 24	12 1

Values of log *r*, log Δ: September 21, 0·2364, 9·9411; October 15, 0·2737, 9·9730.

A photograph obtained at Bergedorf on August 15 showed a well-defined nucleus and a fan-shaped tail which could be traced for about 1′. The corrections indicated to Ebell's ephemeris were +23s., S. 3·0′.

NOVA CYGNI.—The position of this star referred to the equinox of 1920·0 is R.A. 19h. 56m. 24·77s., N. decl. 53° 24′ 1·3″; annual precession, +1·50s., +9·7″. Examination of past photographs shows no trace of a star in this place on plates taken by Dr. Wolf and Mr. Franklin Adams some fifteen and twelve years ago. They go down to mag. 17 and 15 respectively. Two plates taken at Harvard on 1920 August 9 with a 1-in. lens fail to show it, and it must have been fainter than 9·5. A plate taken by Mr. Nils Tamm in Sweden on August 16 shows it of mag. 7, and a Harvard one of August 19 indicates mag. 4·8. Since the maximum was not reached until August 24, the rise in light occupied more than a week. The total increase in light was at least 15 magnitudes, while that of Nova Aquilæ 1918 was only 11 magnitudes (Harvard Bulletin, 729; *Astr. Nachr.*, 5060).

THE PERTH SECTION OF THE ASTROGRAPHIC CATALOGUE.—The publication of the great Astrographic Catalogue has fallen far behind the expectations that were formed when the scheme was initiated some thirty years ago, but many new observatories have stepped in to fill gaps left in the zones, and these are showing much energy in pushing on their share of the work. The Perth Observatory, under the direction of Mr. N. B. Curlewis, undertook the region from −31° to −41°. The Catalogue will be completed in thirty-six volumes, each containing six hours of R.A. in a single degree of declination. Vols. xvii. to xxiv. have recently been issued. The following table gives the number of stars in each volume and the ratio to the number in C.P.D.:

Plate centre	R.A. 0h.–6h. No. of stars	Ratio	R.A. 6h.–12h. No. of stars	Ratio	R.A. 12h.–18h. No. of stars	Ratio	R.A. 18h.–24h. No. of stars	Ratio.
−36°	7,740	4·7	21,923	2·5	20,766	4·1	19,832	5·0
−37°	7,664	4·4	21,883	2·6	20,667	3·5	14,562	3·8

It will be seen that the ratio varies considerably, being, on the whole, lowest where the star-density is greatest.

The radius of the image is given for stars not fainter than magnitude 8. The fainter stars have their magnitudes indicated by a letter (from A to L) referring to a specially constructed scale; approximately A is of magnitude 8½, and the letters are half-magnitudes apart, so that L is 13½.

The *étoiles de repère*, of which there are about fifteen on each plate, have recently been re-observed with the Perth meridian-circle, and proper motions deduced where necessary. The measured rectangular co-ordinates of all the stars are given to 0·001 of a *réseau* interval. The usual plate-constants and tables for reduction to R.A. and declination are also given, with a note that the constants are deduced on a somewhat different plan from that followed at Greenwich.

Geographers and the Reconstruction of Europe.*

By JOHN MCFARLANE, M.A.

IN the rearrangement of European States which has taken place geographical conditions have, perhaps, not always had the consideration which they deserve, but in an inquiry such as that upon which we are engaged they naturally occupy the first place. It is to the land within the frontier, and not to the frontier itself, that our main consideration should be given. The factors which we have to take into account are those which enable a people to lead a common national life, to develop the economic resources of the region within which they dwell, to communicate freely with other peoples, and to provide not only for the needs of the moment, but so far as possible for those arising out of the natural increase of the population. The principle of self-determination has likewise played an important, if not always a well-defined, part in the rearrangement of Europe. The basis upon which the new nationalities have been constituted is, on the whole, ethnical, though it is true that within the main ethnical divisions advantage has been taken of the further differentiation in racial characteristics arising out of differences in geographical environment, history, language, and religion. But no more striking illustration could be adduced of the strength of ethnic relationships at the present time than the union of the Czechs with the Slovaks, or of the Serbs with the Croats and the Slovenes. Economic considerations, of course, played a great part in the settlement arrived at with Germany, but, on the whole, less weight has been attached to them than to ethnic conditions.

When we come to examine the application of the principles which I have indicated to the settlement of Europe we shall, I think, find that the promise of stability is greatest in those cases where geographical and ethnical conditions are most in harmony, and least where undue weight has been given to conditions which are neither geographical nor ethnical.

The restoration of Alsace-Lorraine to France had always been treated as a foregone conclusion in the event of a successful termination of the war against Germany. From the geographical point of view, however, there are certainly objections to the inclusion of Alsace within French territory. From the economic point of view, however, the great deposits of iron ore in Lorraine constitute its chief attraction for France to-day, just as they appear to have constituted its chief attraction for Germany half a century ago. But the transfer of the province from Germany, which has built up a great industry on the exploitation of its mines, to France, which does not possess in sufficient abundance coal for smelting purposes, together with other arrangements of a territorial or quasi-territorial nature made partly at least in consequence of this transfer, at once raises questions as to the extent to which the economic stability of Germany is threatened. In regard to coal the position is serious. We need not, perhaps, be unduly impressed by the somewhat alarmist attitude of Mr. Keynes, who estimates that on the basis of the 1913 figures Germany, as she is now constituted, will require for the pre-war efficiency of her railways and industries an annual output of 110,000,000 tons, and that instead she will have in future only 100,000,000 tons, of which 40,000,000 tons will be mortgaged to the Allies. In arriving at these figures Mr. Keynes has made an allowance of 18,000,000 tons for decreased production, one-half of which is caused by the German miner having shortened his shift from eight and a half to seven hours per day. This is certainly a deduction which we need not take into account. Mr. Keynes also leaves out of his calculation the fact that previous to the war about 10,000,000 tons per year were sent from Upper Silesia to other parts of Germany, and there is no reason to suppose that this amount need be greatly reduced, especially in view of article 90 of the Treaty of Versailles, which provides that "for a period of fifteen years Poland will permit the produce of the mines of Upper Silesia to be available for sale to purchasers in Germany on terms as favourable as are applicable to like products sold under similar conditions in Poland or in any other country." We have further to take into account the opportunities for economy in the use of coal, the reduction in the amount which will be required for bunkers, the possibility of renewing imports from abroad—to a very limited extent indeed, but still to some extent—and the fact that the French mines are being restored more rapidly than at one time appeared possible. (On the basis of the production of the first four months of 1920 Germany could already reduce her treaty obligations to France by 1,000,000 tons per year.) Taking all these facts into account, it is probably correct to say that when Germany can restore the output of the mines left to her to the 1913 figure, she will, as regards her coal supply for industrial purposes, be in a position not very far removed from that in which she was in 1910, when her total consumption, apart from that at the mines, was about 100,000,000 tons. Our general conclusion, then, is that the territorial arrangements which have been made do not necessarily imperil the economic stability of Germany. The economic consequences of the war are really much more serious than the economic consequences of the peace. Germany has for ten years to make good the difference between the actual and the pre-war production of the French mines which she destroyed. Her own miners are working shorter hours, and as a result her own production is reduced, and as British miners are doing the same she is unable to import from this country. For some years these deductions will represent a loss to her of about 40,000,000 tons per annum, and will undoubtedly make her position a serious one. But to give her either the Saar or the Upper Silesian coalfields would be to enable her to pass on to others the debt which she herself has incurred. The reduction of her annual deliveries of coal to France, Belgium, and Italy was, indeed, the best way in which to show mercy to her.

The position of Poland is geographically weak, partly because its surface features are such that the land has no well-marked individuality, and partly because there are on the east and west no natural boundaries to prevent invasion or to restrain the Poles from wandering far beyond the extreme limits of their State. Polish geographers themselves appear to be conscious of this geographical infirmity. It is, then, to racial feeling rather than to geographical environment that we must look for the basis of the new Polish State, but the intensity with which this feeling is likely to operate varies considerably in different parts of the region which it is proposed to include. The population is sufficiently large and the

* From the opening address of the President of Section E (Geography) delivered at the Cardiff meeting of the British Association on August 24.

Polish element within it sufficiently strong to justify its independence on ethnical grounds. Moreover, the alien elements which it contains are united neither by racial ties nor by contiguity of settlement. Considered as a whole, Poland is at least as pure racially as the United States. When we consider the economic resources of Poland we see that they also make for a strong and united State. It is true that in the past the country has failed to develop as an economic unit, but this is a natural result of the partitions and of the different economic systems which have prevailed in different regions. Even now, however, we can trace the growth of two belts of industrial activity which will eventually unite these different regions. One is situated on the coalfield running from Oppeln in Silesia by Cracow and Lemberg, and is engaged in mining, agriculture, and forestry; while the other extends from Posen by Lodz to Warsaw, and has much agricultural wealth and an important textile industry. Moreover, the conditions, geographical and economic, are favourable to the growth of international trade. If Poland obtains Upper Silesia she will have more coal than she requires, and the Upper Silesian fields will, as in the past, export their surplus produce to the surrounding countries, while the manufacturing districts will continue to find their best markets in the Russian area to the east. The outlets of the State are good, for not only has it for all practical purposes control of the port of Danzig, but it is able to share in the navigation of the Oder and it has easy access to the south by way of the Moravian Gap. It seems obvious, therefore, that Poland can best seek compensation for the weakness of her geographical position by developing the natural resources which lie within her ethnic frontiers. By such a policy the different parts of the country will be more closely bound to one another than it is possible to bind them on a basis of racial affinity and national sentiment alone. Moreover, Poland is essentially the land of the Vistula, and whatever is done to improve navigation on that river will similarly tend to have a unifying effect upon the country as a whole. The mention of the Vistula, however, raises one point where geographical and ethnical conditions stand in marked antagonism to one another. The Poles have naturally tried to move down-stream to the mouth of the river which gives their country what little geographical individuality it possesses, and the Polish corridor is the expression of that movement. On the other hand, the peoples of East and West Prussia are one and the same. The geographical reasons for giving Poland access to the sea are no doubt stronger than the historical reasons for leaving East Prussia united to the remainder of Germany, but strategically the position of the corridor is as bad as it can be, and the solution arrived at may not be accepted as final. Lastly, we may consider the case of East Galicia, which the Poles claim not on geographical grounds, because it is in reality part of the Ukraine, and not on ethnical grounds, because the great majority of the inhabitants are Little Russians, but on the ground that they are, and have for long been, the ruling race in the land. It may also be that they are not uninfluenced by the fact that the region contains considerable stores of mineral oil.

Czecho-Slovakia is in various ways the most interesting country in the reconstructed Europe. Both geographically and ethnically it is marked by some features of great strength, and by others which are a source of considerable weakness to it. Bohemia by its physical structure and its strategic position seems designed by Nature to be the home of a strong and homogeneous people. Moravia attaches itself more or less naturally to it, since it belongs in part to the Bohemian massif, and is in part a dependency of that massif. Slovakia is Carpathian country, with a strip of the Hungarian plain. Thus, while Bohemia possesses great geographical individuality, and Slovakia is at least strategically strong, Czecho-Slovakia as a whole does not possess geographical unity, and is in a sense strategically weak, since Moravia, which unites the two upland wings of the State, lies across the great route which leads from the Adriatic to the plains of Northern Europe. The country might easily, therefore, be cut in two as the result of a successful attack, either from the north or from the south. Later I shall endeavour to indicate certain compensations arising out of this diversity of geographical features, but, for the moment at least, they do not affect our argument. We have, further, to note that the geographical and ethnical conditions are not altogether concordant. In Bohemia we feel justified in arguing that here at least the governing factors are and must be geographical. To partition a country which seems predestined by its geographical features to be united and independent would give rise to an intolerable sense of injustice. In Slovakia also there are racial differences. Within the mountain area the Slovaks form the great majority of the population, but in the valleys and on the plains of the Danube, to which the valleys open out, the Magyar element predominates. Moreover, it is the Magyar element which is racially the stronger, and before which the Slovaks are gradually retiring. Geographical and ethnical conditions, therefore, unite in fixing the political frontier between Magyar and Slovak at the meeting place of hill and plain. But on the west such a frontier would have been politically inexpedient because of its length and irregularity, and economically disadvantageous because the river valleys, of which there are about a dozen, would have had no easy means of communication with one another or with the outside world. Hence the frontier was carried south to the Danube, and about 1,000,000 Magyars were included in the total population of 3,500,000. The danger of transferring territory not on geographical or ethnical, but on economic, grounds could not be more strikingly illustrated. With regard to economic development, the future of the new State would appear to be well assured. Bohemia and Moravia were the most important industrial areas in the old Austrian Empire, and Slovakia, in addition to much good agricultural land, contains considerable stores of coal and iron. But if Czecho-Slovakia is to be knit together into a political and economic unit, its communications will have to be developed. We have already suggested that the geographical diversity of the country offers certain compensations for its lack of unity, but these cannot be taken advantage of until its different regions are more closely knit together than they are at present. The north of Bohemia finds its natural outlet both by rail and water through German ports. The south-east of Bohemia and Moravia look towards Vienna. In Slovakia the railways, with only one important exception, converge upon Budapest. The people appear to be alive to the necessity of remedying this state of affairs, and no fewer than fifteen new railways have been projected which, when completed, will unite Bohemia and Moravia more closely to one another and to Slovakia. Moreover, it is proposed to develop the waterways of the country by constructing a canal from the Danube at Pressburg to the Oder. If these improvements are carried out the position of Czecho-Slovakia will, for an inland State, be remarkably strong. It will have through communication by water with the Black Sea, the North Sea, and the Baltic, and some of the most important land routes of the Continent already run through it. On the other hand, its access to the Adriatic is handicapped by the fact that in order to reach that sea its goods will have to pass through the territory of two, if not three, other States, and however well the doctrine of economic rights of way may sound in theory there are undoubted drawbacks to it in practice. It is probable, therefore, that the development of internal communications will in the end be to the advantage of the German ports, and more especially of Hamburg. But the other outlets of the State will certainly tend towards the preservation of its economic independence.

The exent to which Rumania has improved her position as a result of the war is for the present a matter of speculation. On one hand she has added greatly to the territory which she previously held, and superficially she has rendered it more compact; but on the other she has lost her unity of outlook, and strategically at least weakened her position by the abandonment of the Carpathians as her frontier. Again, whereas before the war she had a fairly homogeneous population—probably from 90 to 95 per cent. of the 7,250,000 people in the country being of Rumanian stock—she has, by the annexation of Transylvania, added an area of 22,000 square miles of territory, in which the Rumanians number less than one and a half millions out of a total of two and two-third millions. In that part of the Banat which she has obtained there is also a considerable alien element. It is in this combination of geographical division and ethnic intermixture that we may foresee a danger to Rumanian unity. The position in the Dobruja is also open to criticism. Geographically the region belongs to Bulgaria, and the Danube will always be regarded as their true frontier by the Bulgarian people. Ethnically its composition is very mixed, and, whatever it was originally, it certainly was not a Rumanian land. But after the Rumanians had rather unwillingly been compelled to accept it in exchange for Bessarabia, filched from them by the Russians, their numbers increased and their economic development of the region, and more especially of the port of Constanza, undoubtedly gave them some claims to the northern part of it. As so often happens, however, when a country receives part of a natural region beyond its former boundaries, Rumania is fertile in excuses for annexing more of the Dobruja. To the southern part, which she received after the Balkan wars, and in the possession of which she has been confirmed by the peace terms with Bulgaria, she has neither ethnically nor economically any manner of right. Her occupation of it will inevitably draw Rumania on to further intervention in Bulgarian affairs. The arrangements which have been made with regard to the Banat must be considered in relation to the Magyar position in the Hungarian plain. The eastern country of the Banat, Krasso-Szörény, has a population which is in the main Rumânian, and as it belongs to the Carpathian area it is rightly included with Transylvania in Rumanian territory. In the remainder of the Banat, including Arad, the Rumanians form less than one-third of the total population, which also comprises Magyars, Germans, and Serbs. But Rumania has been permitted to descend from the mountains and Jugo-Slavia to cross the great river which forms her natural boundary, and both have obtained a foothold on the plain, where it may be only too easy for them to seek occasion for further advances. For the extension of Jugo-Slavia beyond the Danube two pleas have been advanced, one ethnical and the other strategic. Neither is really valid. The Danube is certainly a better defensive frontier than the somewhat arbitrary line which the Supreme Council has drawn across the Hungarian plain.

In fact, it is in the treatment of the Hungarian plain that we feel most disposed to criticise the territorial settlements of the Peace Treaties. Geographical principles have been violated by the dismemberment of a region in which the Magyars were in a majority, and in which they were steadily improving their position. Ethnical principles have been violated, both in the north, where a distinctly Magyar region has been added to Slovakia, and in the south, where the western part of the Banat and Bačka have been divided between the Rumanians and the Jugo-Slavs, who together form a minority of the total population. For the transfer of Arad to Rumania and of the Burgenland to Austria more is to be said, but the position as a whole is one of unstable equilibrium, and can only be maintained by support from without. In this part of Europe at least a League of Nations will not have to seek for its troubles.

When we turn to Austria we are confronted with the great tragedy in the reconstruction of Europe. Of that country it could once be said, "Bella gerant alii, tu felix Austria nube," but to-day, when dynastic bonds have been loosened, the constituent parts of the great but heterogeneous empire which she thus built up have each gone its own way. And for that result Austria herself is to blame. She failed to realise that an empire such as hers could only be permanently retained on a basis of common political and economic interest. Instead of adopting such a policy, however, she exploited rather than developed the subject nationalities, and to-day their economic, no less than their political, independence of her is vital to their existence. The entire political reorientation of Austria is necessary if she is to emerge successfully from her present trials, and such a reorientation must be brought about with due regard to geographical and ethnical conditions. The two courses which are open to her lead in opposite directions. On one hand she may become a member of a Danubian confederation, on the other she may throw in her lot with the German people. The first would really imply an attempt to restore the economic position which she held before the war, but it is questionable whether it is either possible or expedient for her to make such an attempt. A Danubian confederation will inevitably be of slow growth, as it is only under the pressure of economic necessity that it will be joined by the various nationalities of south-eastern Europe. Moreover, Austria has in the past shown little capacity to understand the Slav peoples, and in any case her position in what would primarily be a Slav confederation would be an invidious one. For these reasons we turn to the suggestion that Austria should enter the German Empire, which, both on geographical and on ethnical grounds, would appear to be her proper place. Geographically she is German, because the bulk of the territory left to her belongs either to the Alpine range or to the Alpine foreland. Ethnically, of course, she is essentially German. Now, although my argument hitherto has rather endeavoured to show that the transfer of territory from one State to another on purely economic grounds is seldom to be justified, it is equally indefensible to argue that two States which are geographically and ethnically related are not to be allowed to unite their fortunes because it would be to their interest to do so. And that it would be to their interest there seems little doubt. Austria would still be able to derive some of her raw materials and foodstuffs from the Succession States, and she would have, in addition, a great German area in which she would find scope for her commercial and financial activities. Not only would Austria find a market for her industrial products in Germany, but she would also become the great trading centre between Germany and south-east Europe.

The absorption of Austria in Germany is opposed by France, mainly because she cannot conceive that her great secular struggle with the people on the other side of the Rhine will ever come to an end, and she fears the addition of 6,500,000 to the population of her ancient enemy. But quite apart from the fact that Germany and Austria cannot permanently be prevented from following a common destiny if they so desire, and apart from the fact that politically it is desirable they should do so with at least the tacit assent of the Allied Powers rather than in face of their avowed hostility, there are reasons for thinking that any danger to which France might be exposed by the additional man-power given to Germany would be more than compensated for by the altered political condition in Germany herself. Vienna would form an effective counterpoise to Berlin, and all the more so because she is a great geographical centre, while Berlin is more or less a political creation. The South German people have never loved the latter city, and to-day they love her less than ever. In Vienna they would find not only a kindred civilisation with which they would be in sympathy, but also a political leadership to which they would readily give heed. In such a Germany, divided in its allegiance between Berlin and Vienna, Prussian animosity to France would be more or less neutralised. Nor would Germany suffer disproportionately to her gain, since in the intermingling of northern efficiency with southern culture she would find a remedy for much of the present discontents. When the time comes, and Austria seeks to ally herself with her kin, we hope that no impassable obstacle will be placed in her way.

The long and as yet unsettled controversy on the limits of the Italian kingdom illustrates very well the difficulties which may arise when geographical and ethnical conditions are subordinated to considerations of military strategy, history, and sentiment in the determination of national boundaries. The annexation of the Alto Adige has been generally accepted as inevitable. It is true that the population is German, but here, as in Bohemia, geographical conditions appear to speak the final word. Strategically also the frontier is good, and will do much to allay Italian anxiety with regard to the future. Hence, although ethnical conditions are to some extent ignored, the settlement which has been made will probably be a lasting one.

On the east the natural frontier of Italy obviously runs across the uplands from some point near the eastern extremity of the Carnic Alps to the Adriatic. The pre-war frontier was unsatisfactory for one reason, because it assigned to Austria the essentially Italian region of the Lower Isonzo. But once the lowlands are left on the west, the uplands which border them on the east, whether Alpine or Karst, mark the natural limits of the Italian kingdom, and beyond a position on them for strategic reasons the Italians have no claims in this direction except what they can establish on ethnical grounds. In Carniola the Slovenes are in a large majority, and in Gorizia they also form the bulk of the population. On the other hand, in the town and district of Trieste the Italians predominate, and they also form a solid block on the west coast of Istria, though the rest of that country is peopled mainly by Slovenes. It seems to follow, therefore, that the plains of the Isonzo, the district of Trieste, and the west coast of Istria, with as much of the neighbouring upland as is necessary to secure their safety and communications, should be Italian, and that the remainder should pass to the Jugo-Slavs. The so-called Wilson line, which runs from the neighbourhood of Tarvis to the mouth of the Arsa, met these requirements fairly well, though it placed from 300,000 to 400,000 Jugo-Slavs under Italian rule to less than 50,000 Italians, half of whom are in Fiume itself, transferred to the Jugo-Slavs. Any additional territory must, by incorporating a larger alien element, be a source of weakness and not of strength to Italy. To Fiume the Italians have no claim beyond the fact that in the town itself they slightly outnumber the Croats, though in the double town of Fiume-Sushak there is a large Slav majority. Beyond the sentimental reasons which they urge in public, however, there is the economic argument, which, perhaps wisely, they keep in the background. So long as Trieste and Fiume belonged to the same empire the limits within which each operated were fairly well defined, but if Fiume becomes Jugo-Slav it will not only prove a serious rival to Trieste, but will prevent Italy from exercising absolute control over much of the trade of Central Europe. Its development is more fully assured as the one great port of Jugo-Slavia than under any other form of government. With regard to Italian claims in the Adriatic little need be said. To the Dalmatian coast Italy has no right either on geographical or on ethnical grounds, and the possession of Pola, Valona, and some of the islands gives her all the strategic advantages which she has reason to demand.

Of the prospects of Jugo-Slavia it is hard to speak with any feeling of certainty. With the exception of parts of Croatia-Slavonia and of southern Hungary, the country is from the physical point of view essentially Balkan, and diversity rather than unity is its most pronounced characteristic. Ethnic affinity forms the real basis of union, but whether that union implies unity is another matter. It is arguable that repulsion from the various peoples—Magyars, Turks, and Austrians—by whom they have been oppressed, rather than the attraction of kinship, is the force which has brought the Jugo-Slavs together. In any case, the obstacles in the way of the growth of a strong national feeling are many. Religious differences are not wanting, and cultural conditions show a wide range. To build up out of elements in many respects so diverse a common nationality without destroying what is best in each will be a long and laborious task. Economic conditions are not likely to be of much assistance. It is true that they are fairly uniform throughout Jugo-Slavia, and it is improbable that the economic interests of different regions will conflict to any great extent. On the other hand, since each region is more or less self-supporting, they will naturally unite into an economic whole less easily than if there had been greater diversity. What the future holds for Jugo-Slavia it is as yet impossible to say; but the country is one of great potentialities, and a long period of political rest might render possible the development of an important State.

This brings me to my conclusion. I have endeavoured to consider the great changes which have been made in Europe, not in regard to the extent to which they do or do not comply with the canons of boundary-making—for, after all, there are no frontiers in Europe which can in these days of modern warfare be considered as providing a sure defence—but in regard rather to the stability of the States concerned. A great experiment has been made in the new settlement of Europe, and an experiment which contains at least the germs of success. But in many ways it falls far short of perfection, and even if it were perfect it could not be permanent. The methods which ought to be adopted to render it more equable and to adapt it to changing needs it is not for us to discuss here. But as geographers engaged in the study of the ever-changing relations of man to his environment we can play an important part in the formation of that enlightened public opinion upon which alone a society of nations can be established.

Economics and Statistics at the British Association.

THE meetings of Section F (Economics and Statistics) at the recent meeting of the British Association at Cardiff were characterised by the greater part taken in the programme by the younger students of economics, and the result augurs well for the future of the science. What some of the readers of papers may have lacked in experience and authority they gained in freshness of outlook, in readiness to face the new facts of the post-war situation, and in refusal to be bound by the views of the older generation. It would have been interesting had some of the older representatives of the science been present to see the clash of the old ideas and the new; in their absence some of the less orthodox views went almost unchallenged.

In the first meeting of the Section the application of the co-operative method to economic life was urged in two connections. Mr. L. Smith Gordon (arguing from his experience of Irish conditions, in which he has been associated with Sir Horace Plunkett) dwelt on the necessity of treating agriculture as an industry to be organised on a scientific basis if its psychological and economic demands were to be reconciled with modern conditions. Such a scientific basis could only be found in co-operation. In his view, the undoubted advantages of large-scale farming lay not in the actual work of production, but in the handling and sale of the goods produced; and this thesis he maintained in an examination of the economies open to agriculture. But such advantages do not necessitate the existence of large farmers; the same results can be obtained through the adoption by small men of the co-operative methods already applied in Denmark, Belgium, and Germany, and this has the further advantage of building up a numerous race of independent, prosperous small farmers.

Mr. J. Lassen, a Dane, with twenty years' experience of England, argued for the introduction into this country of the Danish system of credit corporations, and supported his case by a detailed examination of the Danish method. The unique point of the system is that, whereas most financing is usually carried out through corporations of lenders (banks, trust companies, etc.), the Danish system begins with a corporation of borrowers. The borrowers, mainly belonging to one locality, and being known to each other, give joint security for loans, and the general public are asked to lend on this first-class mortgage security. That the system has worked well in Denmark was obvious from its history, but the writer was unable entirely to satisfy the sceptics on two points: first, how, if the system were introduced here, the hard-headed Englishman could be induced to accept unlimited liability; and, secondly, how the public could be induced to subscribe to bonds which are liable to depreciation and do not yield an abnormally high rate of interest. There seemed to be some subtle difference in the psychology of the Dane and the Englishman which remained unexplained.

From co-operation the Section passed to the consideration of coal. Mr. J. O. Cheetham analysed the present coal situation with special reference to its effects on the shipping interests of Cardiff. His main subject was the falling output, an examination of its causes and results, and suggestions for increasing production. In 1913 the coal produced in the United Kingdom amounted to 287,000,000 tons, in 1919 to 229,000,000 tons—a fall of 58,000,000 tons. In the same period the numbers employed in the industry increased from 1,128,000 by 63,000 to 1,191,000; and the output per person employed in the industry fell from 262 tons to 193 tons per annum. Thus an increase of 6 per cent. in the numbers employed synchronised with a decrease of 20 per cent. in total output. The writer also estimated (though from an *ex parte* statement by employers) that labour costs had increased from 63 per cent. of selling price in 1914 to 75 per cent. of selling price in 1919. Thus the period of Government control of the coal industry was also the period of the decline in total production and in production per head, and of increase in relative labour costs of production. The special causes to which the decline in output was attributed were the introduction of the seven-hours' day and the failure of transport to convey the coal from the pit-head owing to the lack of trucks. In addition, the employers accused the miners of restricted production, and the employees in turn accused the owners of a deliberate holding-up of the development of mines. Mr. Cheetham seemed to hold both charges well grounded, but to think that what was a sin against the community on the part of the miners was natural and justifiable on the part of the owners—a distinction in which it was difficult to follow him. The president of the Section, Dr. Clapham, directed attention to the necessity of discovering to what extent the decreased output was attributable to the employment of a large amount of labour, not in getting coal, but in improving the state of the mines which had been inevitably neglected during the war period.

Mr. R. F. Adgie, in a paper entitled "The Conduct of the Mining Industry," distinguished between the economic and the psychological aspects of the problem of nationalisation. His thesis was that while from the purely economic point of view the argument for nationalisation was inconclusive, from the psychological viewpoint the balance of evidence pointed to the necessity of social ownership and control. On the economic side he pointed out that there had been an undefined amount of waste connected with the conduct of the industry under private ownership in the past. There was a good deal in distribution, since coal sold at the pit-head for 23*s*. 5*d*. was sold to the London consumer at 44*s*., the distribution charges thus amounting to 47 per cent. This leakage, however, could be stopped by large-scale or unified distribution. In some other directions the economic defects of the industry in recent years (reduced output, inefficient working, etc.) were exigencies of the war period, and were rapidly disappearing; and in others uncoordinated effort and inadequate capital resources had been at fault. But on the economic ground alone the analysis of the existing system had not revealed any advantages arising from social ownership and control which could not be achieved under capitalism. From the psychological point of view the case was different. While granting that the best organising ability might not be forthcoming in a socialised mining industry, he contended that in coal-mining the absence of the best trained direction was of less importance than in other industries. On the other hand, the technical staffs were willing to work under a socialised industry, and the miners would co-operate in no other. Without the technical staffs and the manual workers the industry could not function at all, and therefore, on the balance, the introduction of socialised ownership and control was, from the psychological aspect, inevitable.

The third sitting of the Section was devoted to financial problems. The address of Mr. A. H. Gibson covered a wide field, and was mainly historical in its treatment of its subject, "Credit: Inflation and Prices." After a survey of the development of credit institutions, Mr. Gibson pointed out that banks having by common consent collectively become custodians of the available purchasing power, this imposed on them the duty of not expanding credit at a rate proportionately greater than the increasing supplies of commodities, otherwise inflation would necessarily follow. In theory there was no limit to the expansion of bank credit, subject to the banks being able to obtain sufficient legal tender to meet current demands. He explained that "ways and means advances" by the Bank of England had had the effect of increasing the cash reserves of the banks during the war, and therefore banks were compelled to stop expansion of credit. He expressed the opinion that the banks would meet all the demands made on them for legitimate trade requirements. Traders would find that after a time the restriction of credit would enable them (by causing a fall in prices) to conduct their businesses on a lesser amount of floating capital than at present. He reviewed the necessary steps to be taken for deflation, the chief of which, he maintained, was the increase of production without a further increase in wages or profits. Other remedies were the reduction in the purchasing power of the community, the funding of the present floating debt by direct subscriptions from the public and not from the banks, and further retrenchment in public expenditure. The purchasing power of the community was now 1,800,000,000*l.* greater than before the war, and 85 per cent. of this represented bank credit expansion.

One of the worst evils of inflation was that it considerably reduced the export trade of the country because of higher costs of production. Under these conditions high prices would remain, for this country would have little to offer in exchange for imports of foodstuffs and raw materials from foreign countries. Thus the inflation, which appeared of little consequence to the Government during the war, had all the seeds of disruptive forces within it in the case of a country situated like the United Kingdom, dependent for its existence on foreign trade. It had been a suicidal policy, and the harvest was yet to be reaped. High prices, discontent, labour troubles, and the probable loss in the future of a considerable part of our former volume of export trade were some of the fruits of this monetary inflation policy. The Government and the banks would make every effort to make the deflation as gradual as possible, but the process was bound to be accompanied by severe labour troubles and social discontent. He held, however, that however bitter the pill might be, it would be to the ultimate benefit of Labour to accept the inevitable reduction of wages and exert the maximum combined effort with Capital to increase production. A considerable increase in production might even allow the present level of wages to remain. Labour consumed probably 90 per cent. of the fruits of production, and had everything to gain by intensified output and everything to lose by wilfully diminished production.

At the last sitting of the Section the chief contribution was a paper by Mrs. Wooton on "The Future of Earning." Mrs. Wooton's thesis was that there is nothing inherently sacred in the notion of earning; that in recent times the payment of subsidies which had no relation to the value of work done had taken an increasing part in the remuneration of the worker; and that the time had come to recognise the new ground of remuneration and to pay subsidies avowedly as such and not disguised as wages. As evidence of the tendency she pointed to the increased acceptance of the idea of a minimum wage and the growing favour of time- as distinguished from piece-wages. When the minimum wage paid exceeded the value of the work done for which it was paid, then it was no longer earned, but it was really a subsidy to the worker, and it was incompatible with the continuance of payment of a wage.

In the course of the last two or three years research has been carried on by sub-committees of the Section into problems of credit and currency and into the place taken by women in industry during the war. Already several printed reports have been issued by these committees. The Committee on Women in Industry will probably issue a final report, and the Committee on Credit and Currency has been continued for another year and will issue its report in the summer of 1921.

The International Congress of Physiologists.

AMONGST the results of the outbreak of war in 1914 was the making of it impossible for physiologists to assemble together as was their wont every three years. But now that Europe is recovering from the conflict, physiologists from different countries have been able to assemble, and they did so in Paris on July 15–20.

The congress was under the presidency of Prof. Richet, of the chair of physiology at the Sorbonne, who was assisted by the vice-president, Prof. Gley, of the chair of general biology at the Collège de France. It was informally opened on the evening of Wednesday, July 14, by a *réunion amicale* in the laboratories of physiology at the Sorbonne. This conversazione gave opportunities for old friends to forgather and to make arrangements for the congress-week.

At ten o'clock on the following morning the congress was formally opened by a convocation in the great lecture-hall of chemistry at the Sorbonne. The amphitheatre had been transformed by means of crimson curtains and gilded chairs into a *salle d'honneur* for the occasion. Prof. Richet occupied the chair, and was supported by the Minister of Public Instruction, Prof. Gley, Prof. Fano, Prof. Fredericq of Liége, Profs. Sir E. Sharpey Schafer, Langley, Sherrington, Waller, and others.

The presidential address was simple, dignified, and impressive. The president began by recalling the names of those physiologists who had passed away from their labours since the last congress at Groningen in 1913. No sooner had he finished this part of his discourse than the whole assembly rose to their feet and remained standing in silence for some short time. It was quite spontaneous, so French, so exactly the thing to do at the moment, yet without a trace of anything theatrical or insincere.

The latter part of the address was an interesting survey of such advances in physiology since 1913 as have necessitated changes in our views regarding certain problems. In particular, reference was made to the value of the researches of the American physiologists under Benedict into metabolic exchanges at rest—the so-called "basal metabolism." Prof. Fano, the new occupant of Luciani's chair at Rome, was the next speaker, the subject of his discourse being the two cerebral attributes of volition and inhibition. He made use of data obtained through injuries to the human brain in the late war.

The afternoon was devoted to the reading of papers and to witnessing demonstrations, for which purposes the congress was divided up into five sections, which had to meet simultaneously.

At half-past eight the members were invited to witness a display of scientific kinematography at the Institute of Oceanography in the Rue St. Jacques. At this *séance* the Prince of Monaco and his suite were present. The demonstrations were exceedingly interesting, those of the amœboid movements of the leucocytes in frog's and in human blood being particularly instructive. The rate of reproduction of the films had been accelerated to sixty or eighty times the normal, so that, instead of seeing leucocytes advance on bacilli in the leisurely fashion of their own positive chemiotaxis, they appeared to bolt in and out amongst the *rouleaux* of red discs like so many rabbits amongst the bracken of a warren. Another set of illustrations was equally remarkable: men and animals had been photographed walking, running, and leaping, not only at the rate necessary for the normal reproduction of these movements, but also so rapidly that the transit of the pictures could be brought down to a very slow rate without, however, producing any flicker.

The illusion in the artificially retarded series was very curious; one saw, for instance, a man with a pole in his hand approach a high gate, slowly place the pole on the ground, rise leisurely into the air, float slowly over the gate, and then, having left the pole upright behind him, sink slowly down on the other side. The pole meanwhile fell on one side with a dignity and grace that would not have shamed a Vere de Vere. As a physiological study of the various groups of muscles co-ordinated in actions of this kind, the demonstrations were very valuable. Other series were: the cure of avian beri-beri; the heart and lungs in action in the opened thorax of the cat; hydromedusæ in their tanks; a cat let fall back downwards rotating itself so as to alight on the ground on all fours; and the flying of birds and butterflies in artificially retarded action.

The secretion of pancreatic juice after the injection of secretin into a dog was clearly demonstrated, as also the artificial digestion of a cube of albumen by activated pancreatic juice in presence of the necessary controls. This last demonstration was very remarkable, for in a few moments we were shown the chemical disintegration of the protein into soluble substances, which in reality occupies more than nine hours.

Saturday, July 17, until six o'clock, was given up to the scientific work of the congress. At nine in the evening Prof. and Mme. Richet received the members in their large and handsome house in the Rue de l'Université. It was fortunately a fine, warm evening, so that we were able to stroll about the illuminated garden, where the conversations were not exclusively on scientific subjects.

On the Sunday no scientific work was undertaken, but an excursion was made to the park and château at Chantilly, a place best known to many Englishmen as the site of a racecourse. This proved a very enjoyable visit; the interior of the château is decorated in the stately and gorgeous style of the Renaissance, and the house contains some fine paintings, besides miniatures, valuable gems, and other treasures.

Monday, July 19, saw the congress busily at work again until five o'clock, when there was a large reception at the Hôtel de Ville. This was given by the Mayor of Paris and the City Council; it was a full-dress affair, as might be interred from the costumes of the ladies and from the uniforms and cocked hats of the attendants by whom we were ushered up marble staircases to painted halls. There were speeches of welcome and speeches of thanks in response, as well as generous entertainment.

At nine o'clock the same evening a *soirée* was given by the Club de la Renaissance française in the Rue de Poitiers. This consisted of a concert of chamber music, in which piano, 'cello, and harp all took part. Not for long had some members of the congress, they said, enjoyed an evening so much, for they were enabled for an hour or two to escape from the auditory discords of the streets and to live in an atmosphere of pleasing sounds.

On Tuesday, July 20, the congress was at its work again until half-past two, when the *séance de clôture* took place. At nine o'clock the same evening the Rector of the University of Paris gave a formal reception to the congress in the magnificent salons of the Sorbonne. This was a full-dress conversazione, the entertainment provided, besides some singing, being a recitation by a young actor of one of Alfred de Musset's poems.

During the week several dinner-parties and lunches were given, both the president and Prof. Gley acting frequently as hosts. The number of ladies who as physiologists participated in the congress was larger than at any previous meeting, Great Britain being particularly well represented in this respect.

Not many American or Canadian physiologists attended the congress. American physiology was, however, represented by Prof. Neil Stewart, of Cleveland University, Ohio; Prof. Frederick S. Lee, of Columbia University, New York; Prof. Graham Lusk, of Cornell University, New York; and Dr. L. G. Henderson, of Harvard University.

From Canada there were only Prof. J. J. R. Macleod, of Toronto University, and Prof. Fraser Harris, of Dalhousie University, Halifax, N.S.

The subjects discussed at the congress are too numerous to be dealt with in the detail they deserve. The physiology of adrenalin was the subject of prolonged debate. In particular, doubt was cast upon the trustworthiness of some of the methods for the detection of that hormone in the blood and upon the alleged rapidity with which adrenalin is increased in a very large number of different conditions, some accompanied and some not by emotional factors.

The topics of diabetes, the psycho-galvanic phenomenon of Waller, human calorimetry, the transport of carbon dioxide in the blood, and the condition of the respiratory centre in shock were all discussed at as great length as the overloaded state of the programme permitted.

The congress was too short to deal adequately with all the difficult problems presented for solution. Some of us were just beginning to know one another and to discuss subjects of mutual interest when it was time to part. It was all too short for any lover of Paris, for no lover of brightness and beauty leaves Paris without regret. Some departed for the shell-scarred battlefields of the greatest war in history; others, ere they returned to the routine of their lives, gave one more glance at the gardens of the Tuileries lying in the golden sunshine of the perfect July afternoon as it brought out all the vivid colours of the flowers grouped with such unerring taste.

Memories of the past had been crowding in all that week; did not the word "Sorbonne" at one time import everything that strove against scientific enlightenment, and connote everything that stood for the obscurantism of the Middle Ages?

The historically minded could not but recall that it was in the gardens of the Tuileries one day in 1819 that Laennec devised the first stethoscope. He had been watching some children place their ears on logs of wood to hear sounds conveyed through them, and, seizing on the principle underlying the children's play, he soon invented the stethoscope, one of the earliest instruments of modern medicine.

As we strolled across the gardens we gave a parting glance at the sun-bathed roofs of the Louvre, the most magnificent palace in Europe, a building the history of which is an epitome of the wonderful story of France herself—of her glories, her triumphs, her crimes, and her sorrows. D. Fraser Harris.

University and Educational Intelligence.

The Patent Office Library is open to the public daily except on Sundays, Good Friday, Christmas Day, Whitsun Eve, and Bank Holidays. On and after October 1 the hours of opening will be from 10 a.m. to 9 p.m., except on Christmas Eve and Easter Eve, when the library is closed at 4 p.m.

Dr. R. M. Caven has been appointed to the chair of inorganic and analytical chemistry in the Royal Technical College, Glasgow. This vacancy was caused by the transfer of Dr. F. J. Wilson to the chair of organic chemistry in succession to Dr. I. M. Heilbron, who was recently appointed professor of organic chemistry in the University of Liverpool. Dr. Caven was for many years lecturer in chemistry at University College, Nottingham, a position he resigned to become Principal of the Darlington Technical College.

The new session of the Battersea Polytechnic opens on Tuesday, September 21. A general introductory course has been arranged for students desiring either to qualify for the scholarship or entrance examinations of any of the diploma courses, or to take the Matriculation Examination of London University before taking up a science or engineering degree course. Day and evening courses are provided for those desirous of taking the Intermediate and Final Examinations of London University in science (pure and applied) and in music. Day courses are also available in engineering and other technical subjects, including teachers' courses in sanitary and domestic science. Evening courses are wider in scope; engineering, physics, photography, languages, music and domestic science are among the subjects with which the lectures will deal. Full particulars of all the courses will be found in the Polytechnic Calendar, which can be obtained from the secretary.

A combined effort is at present being made by students and friends of the City and Guilds Engineering College, the Royal School of Mines, and the Royal College of Science in support of the Imperial College War Memorial scheme. The first object in view is the erection in the college buildings of simple memorial tablets bearing the names of the old students—some three hundred in all—who fell in the war. Closely connected with this purpose, and arising out of the desire of ex-Service men and relatives of the fallen to do something of permanent practical value for the students of the college, is the scheme for the acquisition of a sports field. This particular provision for physical development has hitherto been lacking at the Imperial College, and the enterprise now on foot aims at supplying what is generally admitted to be an essential part of the equipment of an educational institution. In response to an appeal issued in May last for 12,000*l*. to enable the scheme to be carried out in its entirety, a sum of more than 6000*l*. has already been subscribed or promised. This has been considered sufficiently encouraging to warrant the acquisition of a suitable ground over which an option had been secured, and the committee is now appealing to all old students and other friends of the Imperial College who have not so far subscribed to take their share in providing the balance of the purchase price and the cost of equipment.

Societies and Academies.

Paris.

Academy of Sciences, August 17.—M. Henri Deslandres in the chair.—G. **Humbert**: The expression of a non-Euclidean area of the fundamental domain related to an indefinite Hermite form.—T. **Carleman**: Singular integral equations with a real and symmetrical nucleus.—M. **Galbrun**: The deformation of a helical spring the extremities of which are constrained.—L. **Barbillion** and M. **Dugit**: A new class of measuring apparatus for the direct evaluation of magnitudes which are functions of two variables. Forms of apparatus now in use, based on the determination of the position of intersection of two rectilinear needles with reference to a curve, are liable to errors of parallax which are difficult to reduce. The type now described is based on the use of a rectilinear needle and a curved needle rotating on a common axis. Two examples of application of the method are suggested: speed indicators for aeroplanes and control of carburettor in internal-combustion motors.—C. **Nordmann**: The absorbing powers of the atmospheres of stars. A method of comparing them and of determining the minimum numerical values.—H. **Gault** and R. **Weick**: A case of isomerism in the series of the aromatic α-keto-acids. In addition to the two isomers of phenylpyruvic acid described by the authors in a recent paper, a third isomer has now been isolated, and the conditions under which these isomers can be transformed into the other forms have been worked out. A study of the reactions of these three compounds leads to the conclusion that two are stereo-isomers possessing the enolic form, and the third is the ketone.—R. **Fosse**: The synthesis of a second diamide, oxamide, by the oxidation of sugar and ammonia. Oxamide has been isolated as one of the products of oxidation of cane-sugar in presence of ammonia by calcium permanganate.—MM. **Tiffeneau** and **Orékhoff**: The hydrobenzoin transformation. The influence of the nature of the reagent. With the exception of the case of triphenylglycol, which reacts in the same manner with different dehydrating agents, according as strong or dilute sulphuric acid is employed, the dehydration of the alkylhydrobenzoins may take place in various ways.—H. A. **Brouwer**: The nature of the diamond-bearing conglomerate of Diamantina, Brazil.—P. W. **Stuart-Menteath**: The tectonic of the Western Pyrenees.—J. **Kunstler**: A treatment preventive of oidium. A handful of sulphur is distributed round the roots of the vine at a depth of 10 to 20 cm.—P. **Wintrebert**: The time of appearance and mode of extension of the sensibility at the surface of the tegument in fishes and amphibians.—C. **Levaditi**: An attempt at the culture of the organism of syphilis in symbiosis with the cellular elements. The culture *in vitro*, in contrast with the virus of poliomyelitis and rabies, not only did not grow, but rapidly lost its vitality and virulence.—F. **Grenet**: The appearance of alcoholic yeast in vineyards. It was noted by Pasteur in 1878 that although mould-spores could be found on the stems of the vines and in the soil at all periods of the year, alcoholic yeast appeared only at the time the grape ripened. The cause of this has now been traced to the fly, *Drosophila melanogaster*, which carries the yeast-spores, and appears in the vineyards only when the grapes are ripe. The origin of the fly has not been traced, nor is it known whence it obtains the yeast-spores.—E. **Joltrain**: The value of Bordst's fixation reaction in the diagnosis of plague. This reaction has rendered great service in cases of doubt in convalescents, and when search for the bacillus has given negative results.—C. **Gessard**: Sub-races of the pyocyanoid bacilli.—L. **Scheffler**, A. **Sartory**, and P. **Pellissier**: The use of silicate of soda in intravenous injections: physiological and therapeutical effects. Sodium silicate solutions may be utilised for intravenous injection in doses worked out empirically. The treatment is beneficial in cases of arterio-sclerosis, in cardio-renal troubles, and in chronic rheumatism. The treatment of tuberculosis by this method is under consideration.

ROME.

Reale Accademia dei Lincei, May 2.—A. Róiti, vice-president, in the chair.—S. **Pincherle**: Complete iteration of x^2-2. The problem has not been resolved for a non-linear function except in very limited cases, of which this is an example.—O. **Tedone**: Some other formulæ of inversion connected with Riemann's method of integration. These formulæ have applications to certain mechanical problems, such as finite wave-motion in an elastic fluid.—F. **Millosevich**: Blödite and other minerals of the saline deposits of Monte Sambuco, in the territory of Calascibetta, Sicily. The salt deposits on the southern face of the mountain, which is in the province of Caltanisetta, are worked by three tunnels, of which the upper cuts through a deposit of hard salt containing local aggregates of the present mineral, which is synonymous with astrakanite, and occurs in two forms, one of which is coloured by iron oxide. The crystallographic data are given, and the analysis indicates the composition $Na_2SO_4.MgSO_4.4H_2O$.—E. **Bompiani**: Point transformations between varieties which satisfy Levi-Civita's parallelism.—R. **Raineri**: Tripoli Corallinaceæ, iii. The species dealt with are *Corallina officinalis*, L., *C. mediterranea*, Areschoug, and *Peyssonelia rubra*, Grev.—Anna **Foà**: Excretory system of the silkworm. The peri- and endo-cardiac and peritracheal glands form a system for the excretion of certain substances probably having an acid reaction. A figure is given of a silkworm injected with carmine and Chinese ink.—A. **Pais**: Convalescence of chronic malaria by X-rays.—Commenting on the foregoing paper, Prof. B. **Grassi** concludes that in the sequelæ of malaria these rays, when opportunely used, have an almost marvellous curative effect, when other remedies, such as quinine, arsenic, iron, diet, and change of air, are much more tardy and uncertain in their action. On the other hand, these remedies can be usefully employed, especially in rebellious cases, in conjunction with ray treatment, but the latter has been shown to be suitable for adoption in every malarial district.—G. **Amantea**. Spermatic secretion, x. The elimination of the sperm in the cavy and rat.—Profs. **Róiti** and **Castelnuovo** referred to the deaths of Theodore Reye, Zeuthen, and Hurwitz; and Prof. Levi-Civita presented reports by C. **Guidi** on the strength of dykes, and by M. **Panetti** on the aerodynamic laboratory adjoining the Polytechnic of Turin.

May 16.—F. D'Ovidio, president, in the chair.—A. **Angeli**: Reactions of some ortho- and para-substitute derivatives of benzol.—Anna **Foà**: Excretory system of the silkworm, ii. The rectal portions of the Malpighian tubes (with three illustrations).—G. **Cotronei**: Identity of metamorphoses of Amphibia anura and urodela.

Books Received.

A Geographical Bibliography of British Ornithology from the Earliest Times to the End of 1918. Part 6. Pp. viii+481–558. (London: Witherby and Co.) 6*s*. net.

Lead: Including Lead Pigments and the Desilverisation of Lead. By Dr. J. A. Smythe. Pp. vii+120. (London: Sir I. Pitman and Sons, Ltd.) 3*s*. net.

Athena: A Year-Book of the Learned World. (The English Speaking Races.) Edited by C. A. Ealand. Pp. viii+392. (London: A. and C. Black.) 15*s*. net.

Handbook of Patent Law of all Countries. By W. P. Thompson. Eighteenth edition, completely revised. Pp. vii+157. (London: Stevens and Sons, Ltd.) 6*s*.

Ancient Egypt. Part iii., 1920. (London: Macmillan and Co., Ltd.) 2*s*. net.

CONTENTS.

NATURE

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The Re-challenge to the Ocean.

WE are glad to notice the general approval with which Prof. Herdman's suggestion of a renewed *Challenger* deep-sea expedition has been received, and we hope that men of science will not fail to take immediate advantage of the present very favourable opportunity for urging upon the Government the renewal of the great enterprise of 1872. Never, unhappily, had the population of these islands to think so much and so anxiously of maritime affairs as during the four years that began in August, 1914. We believe that this concern did not die away when peace was arranged, and we may be sure that very many people are now interested, not only in the further development of our mercantile marine and deep-sea fisheries, but also in the exploration of the ocean as a matter of pure scientific research.

It was, therefore, very fortunate that this was the subject of the Presidential Address at Cardiff, and that the latter succeeded in arousing public interest in a remarkable manner. Politically, also, the time is opportune. Never has the naval supremacy of this country been so unquestioned as it is at the present time, and for this we have to thank the high level of character and resource that has been exhibited by all grades of seagoing men, not only professional sailors but also fishermen and yachtsmen. These qualities must be our best defence in the unforeseeable dangers that may yet threaten us as a nation, and we can think of no better way of cultivating them than by endeavouring to arouse a general interest in everything connected with the sea. Here, then, we have a way, by giving the people the opportunity of following with interest the progress of a great national voyage of deep-sea exploration.

Thus, both from the point of view of national security and that of the development of our marine resources, much is to be said in favour of a renewed *Challenger* expedition, but here our predominant interest ought to be that of pure scientific investigation. It is fifty years since the original proposal for a national oceanographical voyage of exploration was made, and at that time the difficulties of fitting out a ship for that purpose were much greater than they are now: thus, the officers of the *Challenger* hesitated for a long time as to whether they ought to use the recently adopted steel wire for sounding and dredging in preference to hempen rope, and finally they decided upon the latter. In almost every respect the details of oceanographic methods have been improved almost out of recognition. It took several hours then to make a deep sounding, and a whole day to work a dredge for an hour or so in very deep water, and then the results were often uncertain. Now these operations can be carried out expeditiously, and with every prospect of complete success, so greatly have the cable ships improved sounding apparatus and the steam trawlers fishing gear. Plankton methods have been so intensively studied during the last twenty years that it should now be possible to arrange a programme that may solve many theoretical questions with the indispensable economy of labour. Physical and chemical methods for the determination of temperature, density, and other sea-water variables have been developed to a remarkable degree by the international organisation for fishery investigations.

There may possibly be suggestions for new methods of research in the study of the artifices adopted in anti-submarine warfare. We may be certain that with the perfected apparatus now at the disposal of an ocean-going marine-biological and hydrographic expedition results may be obtained much more quickly and accurately than in 1872. It is true that various deep-sea expeditions have been made since the time of the *Challenger*, and that the new methods have been employed. Still, those expeditions were mostly rather small ones, and what is wanted now is a voyage of, at the very least, the duration and scope of that of the *Challenger*. It is also true that all the recent expeditions have been foreign, and that Great Britain has, ever since 1872, lagged behind in this respect. It is owing to our present condition of naval superiority and commercial progress that we should do our share in oceanographical research.

In many ways the outlook is now markedly different from what it was in 1872, and so much more evident is the need for renewed investigation. The detailed study of the results obtained by the *Challenger* herself, and the discussion which these have now received, point to the need for renewed investigation, both on more intensive and more extensive scales. It cannot be said that the recent expeditions afford data for the settlement of most questions. One must never forget what a very insignificant fraction of the whole area of the ocean bottom has been touched by *all* the deep-sea expeditions. There is an enormous tract, said Mr. Tate Regan at the British Association discussion, lying round the Falkland Islands and up as far as Montevideo, which is almost unknown. All this lies within the 100-fathom contour line, and it may be the region of lucrative fisheries. Yet over it all there are only some eight trawling records—two by the *Challenger* and six by the *Albatross*. In these days, when trawler-owners are seeking new grounds, when the British fishery industry looks like being world-wide in its scope, and when steam fishing-vessels can cross the ocean and can fish commercially at depths of 100 to 200 fathoms, such a suggestion cannot be ignored.

All such investigations carried out with the object of discovering fishing-grounds, charting unknown sea-bottoms, or investigating tides and currents from the point of view of the navigator are, of course, utilitarian. But they employ scientific methods and they obtain a great surplus of data to be worked out from a purely scientific point of view. We have not the space here to advert to the enormous importance and theoretical interest of a study of the ocean from the point of view of meteorology. Nor can we insist, as we ought to do, on the reflex value of an arousal of popular interest in marine science. Immersed, as we are at present, in the problems of commerce and industrial production, one is apt to forget how curious are all people connected with the sea in the results of marine research. That popular curiosity and interest is something that scientific organisation ought legitimately to attempt to satisfy.

Philosophical Aspects of Nature.

(1) *The Concept of Nature: Tarner Lectures delivered in Trinity College, November, 1919.* By Prof. A. N. Whitehead. Pp. ix + 202. (Cambridge: At the University Press, 1920.) Price 14*s*. net.

(2) *Lectures on Modern Idealism.* By Josiah Royce. Pp. xii + 266. (New Haven: Yale University Press; London: Humphrey Milford; Oxford University Press, 1919.) Price 12*s*. 6*d*. net.

IT may seem that in bringing together two such widely divergent views and methods as those represented by the present professor of pure mathematics in the Imperial College of Science and Technology, and by the late genial and kindly Harvard professor and leader of modern idealism, the problem with which each of these courses of lectures deals is in danger of being prejudged. Prof. Whitehead's method is severely practical, that of Royce speculative and theoretical. It is, however, in contrasts that the profounder meaning of antithetical theories is revealed. These two courses of lectures—very similar in form and in aim—separated in time by an interval of thirteen years, both deal with the same subject, the concept of Nature, and both are conscious, despite a fundamental divergence, of an identical problem.

(1) The Tarner Lectures of Prof. Whitehead consist of a core of constructive work. Certain kinds of entities are posited for knowledge in sense-awareness. The classification of these, and the investigation of the sorts of relations they can have to one another, form the constructive work undertaken. The most fundamental of these entities are events, and the first kind of relation examined is time. The factors in Nature represented by the conception of space are next brought under review, and the method by which they are analysed is named "extensive abstraction." Space and motion are then considered, and lead to the formulation of a theory of congruence—that is, of measurement in space and time. This plunges us into the relativity controversy, and enables the author to define his position in regard to the theory of Einstein. Finally, we have a theory of "objects," which are described as "the elements in Nature which do not pass." Objects are "recognised," events happen; an event occurs once and is unique, but objects have the character that they can "be again." This core of constructive work has a prologue and an epilogue in the two introductory and the two concluding chapters. It is in these that the problem underlying the concept of Nature is acknowledged, the principle which must rule scientific inquiry discussed, and the issue between the divergent

methods, the *a priori* and the experimental, decided.

Prof. Whitehead sees very clearly and expresses very boldly the philosophical problem of Nature. It is admirably expounded in his chapter on "Theories of the Bifurcation of Nature." By bifurcation he means that Nature is presented first in sense-awareness and then in a conceptual activity of thought. Though the two consequent forms, sense-images and concepts, are inseparable, they are so absolutely distinct that when we reflect on them they present themselves as two totally different kinds, or orders, of facts, between which the relation, so far from being obvious and transparent, is literally incomprehensible. For not only is our sense-awareness fragmentary, requiring an activity of conception to complete it—as when, for example, we conceive another side of the moon—but also the fragmentary appearances themselves are referred to another kind of reality, conceived as existing in itself and called Nature. Physical science treats of electrons, æther waves, and such like, as existent entities, sense-awareness being a special form of the relation of these to the mind. This old philosophical problem has recently forced itself on the attention of physicists by reason of the startling nature of Einstein's special and general relativity principle. In fact, Einstein may truly be said, adapting the famous phrase of Kant, to have roused physicists from their dogmatic slumber. Prof. Whitehead treads the new ground confidently, but yet with caution. He will not have the "curvature of space," and he insists that the concept of Nature shall concern the reality of the observation, unconfused with any question concerning its relation to the observer and his system. To deny the possibility of this detachment is in his view not simple scientific scepticism, but destruction of the basis on which any physical science can be constructed.

(2) The lectures of the late Prof. Royce, originally entitled "Aspects of Post-Kantian Idealism," were first delivered in 1906, and therefore antecede the apparition of the Principle of Relativity. This is not very important, because that principle propounded nothing in the least strange and unfamiliar to philosophers. It is, indeed, essentially one and identical with the principle of idealism. It is its confirmation by experiments which has brought it home with such force to the scientific worker. Although, therefore, the lectures are largely historical, and deal with a philosophical movement and speculation a century old, they are vitally relevant to our present problem. The problem of post-Kantian idealism was essentially the problem of Nature, in particular the fact that while Nature is a concept brought to birth by the mind itself in its intellectual activity, under the stimulus and out of the material provided for it by sense-awareness, yet this concept stands before the mind as necessarily independent and alien in its existence, and as the ground of the existence of the mind itself.

It is curious how, in the historical retrospect of the important philosophical movement which followed Kant, Hegel overshadows all his contemporaries. One of the most interesting portions of this book is the account of the wonderfully brilliant work of Schelling, especially in his early period. No physicist has grappled the problem of Nature with greater zeal or with keener insight than this philosopher.

It is not our purpose to pass judgment, but we commend these two books—both remarkable for their lucidity and intellectual honesty—to all who wish to have a comprehensive grasp of the physical and metaphysical problem of the concept of Nature.

H. Wildon Carr.

The Vehicles of Hereditary Qualities.

The Physical Basis of Heredity. By Prof. T. H. Morgan. (Monographs on Experimental Biology.) Pp. 305. (Philadelphia and London: J. B. Lippincott Co., 1919.) Price 10*s.* 6*d.* net.

So far as the study of heredity means formulating and explaining the resemblances and differences between successive generations great progress has certainly been made, and Prof. Morgan thinks it is mock modesty to refrain from saying that many problems have been solved. The present book is a masterly account of recent work on the physical basis of inheritance, which means, for practical purposes, the chromosomes of the germ-cells. The general evidence in support of the chromosomal theory is once more discussed; its fundamental propositions are clearly stated and abundantly illustrated; and numerous recent subtleties, at varying levels of probability, are explained. The book is indispensable to serious students of biology.

The first general principle is Mendel's law of segregation. The fertilised ovum contains paired factors or genes, causally linked with certain characters; these come into relation to each other, but separate off cleanly in the germ-cells of the offspring, one member of each pair going to one daughter-cell, the other member to the other cell. It is during maturation that the conjugation of homologous (paternal and maternal) chromosomes occurs and is followed by their subsequent segregation. In all probability, apart from hybrids altogether, the germ-plasm of each immature germ-cell is made up of pairs of elements or genes which segregate during maturation. In recent years an entirely unexpected and important discovery has been made in regard to segregating pairs of genes (allelomorphs). In an ever-increasing number of cases it has been found that there may be more than two distinct characters that act as allelomorphs to each other. For example, in mice, yellow, sable, black, white-bellied grey, and grey-bellied grey are allelomorphs—*i.e.* any two may be present (as a pair) in an individual, but never more than two. It may be noted, too, that at an early stage in his argument the author rejects the criticism that Mendelian characters are necessarily superficial characters. He also points out what critics of Mendelism sometimes fail to understand, that species differ from one another, not by a single Mendelian difference, but by many.

Mendel's second law describes the free and independent assortment of the genes. If an immature germ-cell contains the factors or genes—"tall," "short," "colour," "white"—then at maturation the genes "tall" and "colour" (*sit venia verbis*) will go to one daughter-cell, "short" and "white" to the other, or "short" and "colour" to one, and "tall" and "white" to the other. Now the cytological evidence is that each pair of chromosomes, just before the reduction division, consists of a maternal and a paternal member, and there is a free or random assortment of some maternal chromosomes to one pole and some to the other, and similarly for the paternal chromosomes.

But further investigation is disclosing an increasing number of cases in which free assortment does *not* occur. Many characters have been found to keep together in blocks in successive generations instead of assorting freely. This is what is called *Linkage,* one of the post-Mendelian elaborations.

Correlated with the idea of linkage is that of *Crossing Over,* which means an interchange of blocks of genes between homologous pairs of chromosomes. It may be frequent or rare; it may occur in the germ-cells of one sex, but not in those of the other; the size of the blocks may vary at different temperatures and for internal reasons; and a break in one region of the chromosome may interfere with a break in another region. It is altogether very curious and intricate. The genes of a pair do not jump out of one chromosome into the other, so to speak, but are changed by the thread breaking as a piece in front of them or else behind them, but not in both places at once. It is possible that there is a limiting value for crossing over, and if this can be established it may lead to the discovery of the lower limit of the size of the gene. It seems that the crossing over may be effected at the time of the conjugation.

The data in regard to linkage and crossing over lead to the conclusion that the genes are arranged in linear order, standing at definite levels in the chromosomes and definitely spaced. Another interesting suggestion is that the correspondence seen in *Drosophila melanogaster* between the number of linkage groups and the number of chromosomes may hold good generally. Yet another suggestion is to be found in the curious fact, too frequently illustrated to be a coincidence, that one species may have twice as many chromosomes as a closely related one.

In regard to the view that the difference between the sexes is connected with the distribution of particular chromosomes, Prof. Morgan discusses two opposing interpretations. In certain species a female organism develops from a fertilised ovum with two X-chromosomes, while a male organism develops from a fertilised ovum with only one X-chromosome, with or without a Y-chromosome in addition. The question is whether the presence of the two X-chromosomes causes a female to develop, or whether XX is merely an index of sex. According to the author the evidence is now conclusive that sex follows the chromosomes, not the other way round. He shows ingeniously how the chromosome theory of sex may be applied to the interpretation of inter-sexes, gynandromorphs, and allied phenomena.

The conception of a gene or factor seems to become increasingly complex. A gene is to be thought of as a certain amount of material in the chromosome that may separate from the chromosome in which it lies, and be replaced by a corresponding part (and none other) of the homologous chromosome. But it is now becoming clear that a gene is causally associated with *manifold* effects; that different genes may produce characters that are indistinguishable, such as whiteness in poultry; that each character is the product of many genes, and so on. Moreover, the variability of a character is not necessarily due to variability in the gene; much may be due to variability in the environmental conditions of development. Critics of Mendelism must read this book, not necessarily to criticise less, but to criticise more wisely.

There are so many illuminating discussions in Prof. Morgan's book that we find it difficult to stop. Regarding mutations it is pointed out that they are of infrequent occurrence, that the change is definite from the beginning, that some at least are recurrent, and that the difference between the old character and the new is small in some cases and greater in others. But their origin remains obscure. As to their supposed "chance" character, it is pointed out, very usefully we think, that the degree of development of any character increases the probability of further stages in the same direction. Species are to be thought of as groups of genes, and related species have a good many genes in common. Thus similar mutations are likely to occur in different but related species. Of this, indeed, studies on Drosophila have furnished experimental evidence.

We do not know how many books on heredity Prof. T. H. Morgan has written. Their succession marks the rapid advance of a department of science to which his personal investigations have made very important contributions.

New County Histories.

The Victoria History of the Counties of England: Hampshire and the Isle of Wight. Part i., pp. 46+2 maps. Part xv., pp. 409–470+1 plate: *Buckingham.* Parts iv. and vi., pp. 177–205+map and plate. Part xxiii., pp. 312–372+5 plates: *Hertford.* Parts ii. and iii., pp. 43–221+map: *Berkshire.* Part ii., pp. 27–68+map. Part iv., pp. 173–196+map and 12 plates: *Surrey.* Parts i.–iv., pp. 254+4 maps and 2 plates. (London: Constable and Co., Ltd., 1920.) Prices various.

"THE Victoria History," finely conceived and excellent in performance, at the outset in 1900 largely disdained plebeian methods of advertisement. Wealthy country gentlemen were often left in ignorance of its existence, and slender purses were mocked by the high cost to be pledged for the history of any single county. A more considerate policy has now been adopted. Essays by eminent specialists can be purchased separately. Comparison with earlier county histories shows a surprising advance in recognising the importance of natural knowledge.

Since Nature makes merry with man's artificial boundaries, a work taking all our English counties in detail cannot avoid some overlapping and repetition in dealing, for example, with botany and butterflies, with mice and their alliterative contrast, men. The difficulty is enhanced in zoology by the hordes of insects. Records stating when, where, and by whom each species was captured in a particular county become rather appalling. It is a relief to read in the "History of Surrey" that out of 3000 British flies (Diptera) only a miserable tale of 360 can be credited to the county. Yet this luck is "solely due to the paucity of collectors of this order of insects" (p. 151). Though Diptera be few, "the Phytophagous hymenoptera, *i.e.* saw-flies, wood-wasps, and gall-flies, are abundant throughout Surrey." Avoid, however, speaking disrespectfully of saw-flies. "Saw-flies can easily be bred and reared in captivity, and it is only by doing this in large numbers that we can hope to arrive at the laws which control that most mysterious phenomenon, parthenogenesis." Mr. Chawner further declares that a common species, *Poecilosoma puteolum*, produces females only, arguing from the experience that several thousands have been bred for six years in succession, and all turned out to be of that sex (p. 91). Still, it is hard to prove a negative, even for broods to which Sir Ray Lankester's term "impaternate or fatherless" would seem appropriate.

The botanists agree that "the best division of a country for botanical purposes is into river-basins" ("Hertfordshire," Hopkinson, p. 48); to explain the distribution of the flora of Berkshire, "various botanical districts essentially based on the river drainage" are used by Mr. Druce (pp. 29, 51); so also for Surrey Mr. Beeby accepts the division into districts founded on the river-basins "as the most desirable in all respects," with exceptions. The grand exception is, as he explains, that "the geological strata run in such remarkably parallel bands from east to west, while the streams run transversely to them, so that each of the principal rivers has its share of each of the formations." For Surrey Mr. Lamplugh says, "the geological structure of the county is so simple, and its existing features depend so closely upon this structure, that it forms an ideal tract for the study of the elementary principles of the science." The same might be said of the geology of Hampshire as displayed in the late Mr. Clement Reid's luminous treatise. The map of Surrey shows how you may "walk east and west upon the same formation along the line of 'strike' from one end of the county to the other; while if we go southward we soon cross to underlying, and if northward, to overlying beds."

Space permits only bare notice of an important historical disquisition on "Forestry and the New Forest," by Nisbet and Lascelles; and of the profusely illustrated essays on Early and Anglo-Saxon Man in Berks and Bucks by Shrubsole, Clinch, and Reginald Smith; while no attempt can be made to discuss the interesting local history of the "Aylesbury Hundred" of the latter county. In the botany of Surrey the late George Massee leaves a curious note of chronology by saying (p. 65): "The edible boletus (*Boletus edulis*) has a cap corresponding in size and colour to a penny bun." When will the penny bun once more rival the cap of a boletus?

Practical Organic Chemistry.

The Preparation of Organic Compounds. By E. de Barry Barnett. Second edition. Pp. xv+273. (London: J. and A. Churchill, 1920.) Price 10*s*. 6*d*. net.

THE work which the universities were invited to undertake in preparing synthetic drugs and "poison gases" in more than usual laboratory quantities forced them to replace their costly glass and porcelain apparatus, wherever possible, by larger and stronger vessels of tinned iron and by earthenware basins of cheap material. This experience has been wisely turned to account in the new edition of Mr. Barnett's book, in which a description of such apparatus is given. Although it is desirable for the beginner to use transparent vessels, in which reactions can be easily watched and controlled, and to manipulate quantities which do not demand too great an expenditure of time, the knowledge of how to apply larger scale methods he may later be called upon to adopt will prove invaluable. Moreover, the habit of discarding, as occasion demands, the usual laboratory vessels in favour of less elegant but more serviceable utensils is a good mental and moral exercise. With the exception of the above-mentioned description and the addition of a few new preparations, no fundamental change has been made in the size and scope of the new edition. It takes the form made familiar by Gattermann's and Freundler's well-known treatises, and by many other books dealing with this subject.

Which of the two systems is the more satisfactory, namely, discussing general methods and apparatus first, and then referring to them in the later preparations, or allowing the student to familiarise himself with them by actual examples involving their use, must be left to the individual teacher to decide. He must also determine what amount of detail he thinks it desirable to supply in his account of the preparations. There is no doubt that some simple modification in the conduct of a reaction which additional details would supply will often convert failure into success, with a corresponding economy in the student's time. On the other hand, advantage may be gained by the student having to surmount his own difficulties.

There is, on the whole, not much to choose between the two methods. The present writer is inclined to think that, as the purpose of the practical work is mainly to assist the student in developing his general knowledge of organic chemistry, the greater the variety of reactions he can perform during his course, which is often not too long, the more he will profit by it. Later research will afford ample opportunity for the exercise of his ingenuity in meeting and overcoming difficulties.

J. B. C.

Our Bookshelf.

The Essentials of Histology: Descriptive and Practical. For the Use of Students. By Sir E. Sharpey Schafer. Eleventh edition. Pp. xii+577. (London: Longmans, Green, and Co., 1920.) Price 14*s*. net.

"THE Essentials of Histology" preserves, in its eleventh edition, the well-known characteristics of the previous editions of this standard work. The volume is growing in size, but the additions are mainly of new illustrations. These are uniformly good, and conform to the general tendency of successive editions to present photographic representations of actual preparations, as well as semi-diagrammatic drawings emphasising points which the artist deems of special import. The latter are of great service to the beginner, but carefully selected photographs mean more to the advanced student. Both varieties are utilised in the "Essentials," and monotony in the figures is avoided by a pleasing use of colour. Although mainly a descriptive work, the practical side is better represented than a cursory glance would reveal, and the directions briefly given at the head of each lesson are amply sufficient, if exactly followed, to enable the student to obtain the preparations desired. Further practical directions are given in the appendix, which is a synopsis of general and special histological methods.

A Naturalist on the Amazons. By H. W. Bates. Abridged and edited for schools by Dr. F. A. Bruton. (English Literature for Secondary Schools.) Pp. xix+182. (London: Macmillan and Co., Ltd., 1920.) Price 2*s*. 6*d*.

IN this abridged edition selections from Bates's original work have been chosen which deal mainly with the natural history of the forests of the Amazon. A short account of the more remarkable forest trees is included, but the bulk of the book consists of selections describing the fauna of the country. Illustrations from photographs are given of most of the animals mentioned. Dr. Bruton contributes an interesting introduction and some helpful notes. We are glad that Bates's vivid descriptions of Nature and man are made available for appreciation by young people in schools by the issue of this abridged edition of his masterpiece.

The Advancement of Science: 1920. Addresses delivered at the 88th Annual Meeting of the British Association for the Advancement of Science. Cardiff, August, 1920. (London: John Murray, n.d.) Price 6*s*. net.

IN this volume are published the presidential addresses delivered at the recent meeting of the British Association at Cardiff. Such a collection, representing, as it does, the views of the leading authorities on progress made in various departments, and discussing some problems of prime interest, will be welcome to all students of science as well as to many members of the educated public. We hope the demand for the volume will justify the attempt of the Association to secure a wider circle of readers for the most interesting contributions to its annual meeting.

A Handbook of Physics and Chemistry. By H. E. Corbin and A. M. Stewart. Fifth edition. Pp. viii+496. (London: J. and A. Churchill, 1920.) Price 15*s*. net.

THE requirements of the new syllabus for the First Examination in physics and chemistry of the Conjoint Board of the Royal Colleges of Physicians and Surgeons have made it necessary to double the size of the volume issued in 1899. Short articles on statics, hydrostatics, expansion, refraction, absorption spectra, current electricity, ionisation, and radio-activity have been added in order to meet the new syllabus, and much new matter has been inserted with the view of making the book more useful to students preparing for other elementary examinations in physics and chemistry.

Common Diatoms. By Thos. K. Mellor. Pp. 16 + plates. (London: William Wesley and Son, 1920.) Price 6*s*. net.

THIS little pamphlet consists of eight pages of introduction, followed by a general index and seven plates of diatoms. The author's intention is to illustrate such diatoms as are usually found on "circle" slides sold by opticians, from such districts as England, Japan, Hungary, New Zealand, Istria, Samoa, the Adriatic Sea, Maryland, etc. The seven plates contain about 400 figures, and are fairly well drawn.

The introductory remarks are of a popular description, and do not profess to deal with diatoms from a scientific point of view.

Problems in Physical Chemistry: With Practical Applications. By Dr. Edmund B. R. Prideaux. Second edition, revised. Pp. xii+294. (London: Constable and Co., Ltd., 1920.) Price 18*s*. net.

DR. PRIDEAUX's book, in its first edition, was found useful by teachers and students of physical chemistry, and served a very important purpose by assisting in directing the teaching of the subject into practical and intelligible channels. The new edition has been carefully revised and improved in many respects. The high price of the book, which is somewhat poorly bound and printed on not very good paper, will be the main drawback to its popularity among students.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The British Association.

THE Cardiff meeting of the British Association was pleasant and profitable in various ways, but the membership in an important and prosperous city like Cardiff might have been larger, and a certain amount of apathy on the part of the public in general to the presence of the Association was noticed. The Press did its best, but perhaps an influx of material prosperity has rendered folk temporarily callous to other forms of activity. My recollection of the Cardiff meeting in 1891 is that it excited more local interest—perhaps because it was the first in the city; perhaps also because the meeting included the week-end, extending from Wednesday to Wednesday, instead of ruthlessly encroaching on the four chief working days of the week and beginning sectional operations ten hours before the president's opening address. It is understood that future meetings will return to pre-war conditions in this and other respects. Other improvements may be desirable, so the manifesto of your Cardiff correspondent, Dr. R. V. Stanford, on p. 13 of NATURE of September 2 is opportune and timely.

The British Association differs from other learned societies in that it does address the general public, and travels from place to place in order to reach a wide constituency. In so far, therefore, as it takes the easier course and caters merely for specialists, it is not fully executing its mission. Its function might be described as bringing the general public into personal contact with a scientific discoverer and giving them some inkling of his methods and results. Technicalities are not always inappropriate, so they be suitably expounded; for no one can suppose that scientific work is a simple and easy matter readily understanded of the people.

If the public were treated to nothing but the superficial froth they would rightly feel defrauded; they wish to realise that a plenitude of coherent material lies beneath the surface, much of it necessarily rather deep. The enthusiasm of a scientific worker is, or should be, contagious; and an impression of real value and interest can be produced, in spite of a plentiful lack of understanding.

Moreover, though it is difficult to overestimate the ignorance of the bulk of the population, there are likely to be in every civic community a few young minds, instinctively eager and unconsciously able, who may be stimulated by a discourse from a great man and become themselves disciples, and ultimately even co-workers. The awakening of one such youth per meeting would be well worth while; nor is it too much to expect. No one can tell beforehand what particular seed will come to fruition, and instances of such awakening in the past are historic. What is called science-teaching at schools has been known before now to have a depressing effect; direct aiming at a result may not achieve it; unorganised and indirect impersonal instruction, coupled with unconscious personal influence, may occasionally be far more stimulating.

To come to details, avoiding every sort of contemporary allusion and speaking quite generally:

The President's Address should, as a rule, deal with some comprehensive and enlightening theme; but the president is an individual liable to be overweighted by the opportunity for a responsible, more or less ponderous, utterance, and it is useless to legislate for an individual.

The function of the two evening lectures is fairly understood, and great trouble is sometimes taken over their illustration. They can be approximately on the lines of a Friday evening discourse at the Royal Institution, but should be still more popular, because the audience, for the most part, will not be so experienced and specifically cultivated. They should not, of course, be of the mere elementary "popular lecture" type, and the manner of presentation should be such as to arouse admiration even in those specialists who are learned in the particular subject treated of. But whereas at the Royal Institution it is customary to hear a man discourse on his own investigations, no such tradition naturally exists at the British Association; the work of a foreigner or of a recluse may be described, or any other topic dealt with which either is in the public mind already or may be conveniently introduced there. These lectures are also an opportunity for interesting not only the general public, but also the working members of the Association belonging to other sections, who are glad of an opportunity of hearing something authoritatively and well expounded by an expert in some branch of science other than their own.

If examples are permissible, Clerk Maxwell's discourse on "Molecules" in 1873 at Bradford was not only profoundly, absorbingly, interesting at the time of delivery, but was a genuine elucidation of the molecular problems of that day and of the kinetic theory of gases; and Huxley's discourse on "Animal Automatism," the year afterwards at Belfast, was a marvel of eloquence free from adventitious aids or accessories of any kind.

So far agreement may be expected; difficulties begin when we contemplate the work of the sections. Here a certain amount of specialisation is inevitable, and the public who attend the sections expect, and on the whole enjoy, proceedings rather out of their depth. Yet still there are ways of interesting experts without being wholy unintelligible to everyone else. Dullness, indistinctness, inaudibility, and the absence of clarity, are not appreciated even by experts, though much may be forgiven when the matter is new or important. But liveliness and suggestiveness are specially appropriate at sectional meetings, attended as they are by kindly hosts who are anxious to get some glimmering of what science "feels like" to those engaged in it, whom they are for the nonce entertaining. It is probably unwise to limit the proceedings to the delivery of set papers according to a prearranged and rigid programme.

Of late years there has been a tendency to curb and curtail discussions for the sake of completing each item of a programme so far as possible to time. But in the old days discussions were often the most lively, and sometimes the most instructive and suggestive, part of the meeting. Kelvin and Stokes, Maxwell and Rayleigh, FitzGerald and Larmor—these were men worth hearing; and, whether they happened to contribute papers or not, their presence was stimulating and their remarks encouraging to the younger men. It was at one of these meetings long ago that the then unknown J. P. Joule was "discovered," and many another young man was brought into notice by the enthusiasm of Sir William Thomson and the giants of his era. Then again, Cayley and Sylvester, H. J. S. Smith, W. K. Clifford, and one or two still living, shone brilliantly in pure mathematics; and there were the Astronomers as well. Blackboards full of equations were far more frequent than the dim and depressing atmosphere required for lantern-slides, and the audience found this manner of exposition exhilarating in its own peculiar way. To see physical results emerging from chalk and duster is always an astonishing and edifying spectacle. The realities of physical investigation, and their obviously recondite character, contribute to respect. Brilliant mathematical exposition is both cheaper and easier, in a peripatetic society, than brilliant experimenting; and if both are forbidden, the true atmosphere of science is not represented. Diagrams are more trouble than lantern-slides, but are in many respects better.

I see I am speaking of the *personnel* of Section A only—it is inevitable—but I suppose that something of the same sort must have been occurring in other of the older sections; certainly a large *clientèle* assembled whenever Huxley was expected to speak, and sometimes he was quite reasonably technical in substance as well as literary in form. Are we to conclude that there were giants in those days, and despair of maintaining the standard? There is splendid work being done now, but the conditions somehow seem less attractive.

Let me be not misunderstood as making any complaint! The proceedings in Section A were brilliant this year, from the president's address downwards, and one came away full of admiration for the work of the present generation; but the programme was rather too full. So it used to be long ago also, though four hours were then given to it instead of three, and no kind of time-table was attempted. When Sir William Thomson got into his stride few presidents had the hardihood to check him or to curtail his sometimes rambling eloquence; while his young disciples were conscious of enthusiasm and enlightenment, commingled with occasional boredom, and the audience was often delighted with his vivacity, however little they were able to follow.

I feel sure that among the younger men now there are some whose more frequent contributions to a discussion would be most welcome, but the incubus of a set programme and limited time, together with apparently an over-modest expectation of hypercriticism from their immediate fellows, seems to restrain them. The secretaries of Sections used not to limit their activities to providing for the revelations of others; they shed a light of their own. No self-denying ordinance was inflicted on the president, the vice-presidents sat on the platform, and when a lively discussion seemed to be beginning the exigencies of the programme were ignored. The discussions I speak of were not formally arranged; they arose spontaneously. I remember, for instance, a lively passage-of-arms between Herbert Spencer and Clerk Maxwell on a thermodynamical subject. Sometimes there were real controversies, and occasionally some dissipation of energy in the form of heat. The modern prearranged discussions are an innovation—possibly a good one—but in organising such a discussion it has turned out to be a mistake to fire off a group of more or less allied papers by way of an opening. Disconnected and separately conceived papers do not really open; they are apt to dissipate interest and stop real discussion, partly by too extended a range, partly by consumption of time.

The procedure of a "debate," one proposer and one opposer, followed by spontaneous and unprepared speeches which really deal with the points raised, would seem a not impossible ideal.

It must be admitted that the more elastic and semi-random procedure of old days sometimes entailed disappointment, especially among the butterfly visitors who flitted from section to section trying to be present wherever a well-known speaker was on his feet. A rather futile proceeding it usually was, and yet there was merit in it from the missionary point of view. But the butterflies must take their chance; it is the more steady and persevering insects for whom we should aim at providing honey.

How to do it I confess I know not with any certainty; yet it must be known beforehand, in a general way, that one or two subjects will in all probability prove attractive, and it is a pity when, through lack of collaboration between the sections, a number of such attractions compete for attention on a single day.

The General Secretaries have striven this year to unite the office-bearers of the different sections, and generally to carry forward or renew the old traditions so far as possible. It may be hoped that their efforts will have a good effect in the future.

Oliver J. Lodge.

Normanton, Lake, Salisbury, September 10.

P.S.—Since writing the above I have seen your leading article in Nature of September 16. I perceive that you hold views similar in many respects to my own, and I anticipate that many readers of Nature will be in agreement, now that you have given them an opportunity of reconnoitring the whole position. O. J. L.

September 17.

Allow me to express my concurrence in the view presented in the leading article in Nature of September 16 as to the necessity for a re-organisation—a re-adjustment to the needs of the day—of the British Association for the Advancement of Science. The Association has been allowed to develop and grow in various directions without sufficient control or consideration as to how it may best serve the purpose for which it exists. It was at first a society of a missionary character, aiming at spreading in the dark regions of these islands a knowledge of and interest in science. Soon it added to this purpose that of an annual picnic and friendly gathering of workers in science. Then followed the gathering of funds by fees for membership; the application of those funds to pay, here and there, for research. Later ensued an extended and overwhelming creation of "sections," so as to give all sorts of people a meeting ground for discussion and, incidentally, for self-advertisement. The result of the last step was an embarrassing demand for meeting-rooms and committee-rooms to be provided by the town which had invited the Association to give it a visit. At the same time the subdivision of subjects led to a dilution of quality, and a free bid for popularity and newspaper notice—which has rendered the proceedings of the Association of diminishing interest and value to the educated classes, not only in the locality of its meeting, but also throughout the country. Serious workers in science are now well provided in our great cities with societies and journals by aid of which new work may be discussed. No one is particularly anxious to follow the lengthy, and frequently non-authoritative, disquisitions which the sectional meetings, as at present organised, tend to promote.

The annual meetings of the Association might be carefully arranged beforehand by the executive so as to secure the consideration and clear exposition to the public of a few definite matters of actual moment. The "sections" of the meeting could with great advantage be reduced to four, and the addresses to be given by the president of each section, and also the "papers" accepted for consideration, limited to subjects chosen by the executive of the Association. The individuals chosen to preside or to introduce a subject should be men whose names and works are such as to command the attention and presence of the leaders of thought and social life in the district where the meeting is held.

The only wise alternative to this reconstruction seems to me to be a frank restriction of the meetings of the Association to men from all parts engaged in scientific work, glad to meet one another once a year in pretty and suitable spots (such as our old university towns and smaller cathedral cities), there to exchange in more or less intimate meeting—without the disturbing influence of newspaper reporters and notoriety hunters—recitals and exhibitions of the progress of their researches. Such are (or were) some of the associations of scientific workers in Continental countries. Meetings of this class involve little or no expense or trouble to their participants. The use for a week of a "refreshment hall" and public garden is all that is needful for the gatherings of the hundred or two *savants* who alone are eligible as members or anxious to be present. These meetings are often delightful, and lead to informal and productive discussions and personal friendships of permanent value.

I think that our "British Association" is in an unhealthy condition owing to the attempt made by it—not deliberately, but by constitutional looseness of purpose—to combine the features of a friendly picnic and smoking debate with the work of a national conference dealing (under the disadvantage of public ignorance and journalistic inaccuracy) with great questions of national importance. A choice must be made between "picnic" and "conference." I should prefer the picnic. E. Ray Lankester.

September 17.

Your criticism of the British Association, that it fails to touch our national life, is most opportune; but whereas you imply merely that it is decadent, to me it seems to be practically defunct. An active worker on its behalf in the past, I have little hope of its resuscitation and doubt if it can ever again fulfil the desires of its early promoters, who undoubtedly held its primary function to be that of advancing public appreciation of scientific discovery. I have always deplored our failure to appeal to the public. Seemingly, the spirit of sacrifice is gone out of science; strange to say, the herd instinct is altogether wanting in our society, so uncontrolled is our individuality. The assumed author of "The Beggar's Opera," after remarking of his characters, "There's not an honourable man among them, nor an honest woman," proceeds to say, "but they are all human." So are the present exploiters of the British Association, though were it not human to be selfish some might even dub them inhuman on account of the narrowness of their outlook and their disregard of public needs.

The neglect of science by the nation has long been the favourite text of the scientific preacher; it occurs to none to consider how complete is the neglect of the nation of which scientific workers have long been consistently guilty. Few seem to realise how great has been our failure of late to make any concerted effort to enlighten the man in the street, how little right we have to despise his ignorance. Scientific jargonese so fills the air that it would be refreshing to go back to Babylon and the Tower of Babel; scarce a readable book, fit for general consumption, is written on any branch of our scientific work. We ever walk on stilts; little wonder that the public does not reach up to us.

Like every other institution, the Association is a failure for want of leaders; and as discipline is gone out of society and children in these days think themselves superior to their parents—as demonstrated recently in the columns of the *Morning Post*—it is doubtful if, in the future, leaders will be recognised. Men with the Olympic genius of Huxley and with his profound belief in truth are creations of great rarity; even men like Michael Foster, his body-slave, are no longer to be found. Though not gifted with any high degree of imagination, Foster's was a sympathetic nature; he was ever on the look-out for suggestions and ever ready, when a good purpose was mooted, to help in bringing people together to accomplish it. The Royal Society has been a lifeless body since it lost his guiding hand; it has allowed its proper functions to be abrogated in every direction. Nothing, for example, could be more lamentable than its abandonment of the control of scientific research to the bureaucrats.

The British Association no longer has any real influence either on science or on the public. It has ceased to count, more especially since it lost the services of the late Mr. George Griffith, who rendered it such signal service while secretary. Griffith was the ideal official; he had feeling for every subject and his contagious influence in bringing about an understanding between elements often diverse in character was very great. He enticed all its members into active co-operation; his one desire was ever to make the Association of avail.

Of late years the secretariat has been a forbidding rather than an attracting institution; it has not only lacked imagination and "go," it has also had no ideals; and yet it has monopolised control, with the aid of a few elderly amiables who have been persuaded into the belief that they were bosses of the show.

The young man has been too little noticed; being afraid to speak out, feeling that his elders resent any expression of opinion, he has had no reason to take an active interest in the Association. The young man must be more cared for in future.

If the Association be continued, its constitution must be entirely changed. It is, perhaps, significant that at Cardiff the general committee relegated to a committee the appointment of a new treasurer—really a matter to be dealt with by the council. In point of fact, the council exists only in name; control rests with the official ring, who resent every criticism and any intervention with ideas. I would suggest that the two secretaries and the treasurer should each be appointed for three years, not more, so that every subject might be represented in turn; if only one of the three were appointed in any one year, the remaining two would always be men who had some previous experience of office. The council might consist of the officers, together with the president, the president of the previous year, the president-designate and a single delegate from each of the sections, half of these delegates being chosen afresh either each year or every other year. The business of the Association should be entirely carried out at meetings of the council, not settled previously by an official caucus. The delegate from a section should each year present a report to his sectional committee so as to bring the proceedings of the council under discussion.

The functions of the general committee need to be more clearly defined and perhaps limited; the "freak" has too great a chance at present and as no one knows what topic is to come under consideration, the discussions are rarely representative of the real state of opinion.

Of late the Association has lost what little hold it had on the public generally, owing to the commercialisation of the Press; even the *Times* is now given over to tit-bit-ery and the reports it prints of the Association meetings are worthless for all practical purposes. Some new method of running the scientific publicity campaign must be thought out. It may be worth while for the Association to spend its annual income on advertising in two or three of the chief papers, arranging that between them these report the proceedings in full. Money for research can now be had from other sources and the public has the right to demand that, being taxed for research, its contribution to the Association shall be used largely on its own behalf.

As to the work of the annual meeting, I am entirely with you in thinking that the sections should unite in treating subjects broadly on lines such as the Faraday Society has followed. Instead of a dozen separate sections sitting each year, it would be far better to have at most four.

The discourse delivered by Prof. Eddington may be referred to as an example of the address which appeals to specialists; it is of enthralling interest, yet far too technical; many of the conclusions arrived at need explanation to make them clear to the scientific mind not specially versed in the subject. Such an address, in fact, needs considerable working up to make it of avail even to the instructed reader.

Subjects can always be found on which we need posting up which are of general as well as of special interest; for example, what precisely is the present state of the evidence in favour of evolution? "General" Bramwell Booth scoffs at the conception as "stuff and nonsense." With what case can we confront him and literary quibblers like Mr. G. K. Chesterton? It is long since Huxley discussed the horse in public; in the interval much new evidence has been brought to light which should be presented. The chalk has told an undeniable story, yet how many know it? It is our own fault that the ecclesiastically minded, in their ignorance, speak of us as though we were mere speculators in knowledge, constantly shifting hypotheses without ever arriving at clear conclusions.

To mention other subjects, at the moment the fuel problem is one of the greatest importance; only the food problem is of greater urgency. On matters such as these the public stands much in need of enlightenment. Obviously, each town visited would be interested in having some particular subject special to itself treated exhaustively.

To make the meeting of more than local and passing value, the essays brought forward in the sections for criticism and discussion should be printed in advance and published, with the considered discussions, without any delay. Such a book of authoritative opinion could not but find a ready sale.

If something serious were attempted, something serious would be done. Now everything is attempted and little, if anything, done. Insisting, as we constantly do, on the value of education, it is imperative that we show ourselves educable and ready to read the signs of the times.

HENRY E. ARMSTRONG.

THE leading article in NATURE of September 16 gives articulation to notions which have been very prevalent of late. One does, indeed, occasionally hear the suggestion made that the British Association has outlived its period of usefulness, but most of us, I think, are of opinion that the virility of this nonagenarian institution is such that it should effect even more during its next ninety years than in its past to promote the objects laid down in clause 1 of chap. i. of its rules. One feels, however, that some infusion of modernity is necessary if the best possible future is to be built up upon the fine traditions of our Association. With your permission I will remark on certain impediments to progress resulting from the present form of organisation, and suggest, with some diffidence, a possible means for their removal.

The Association is really run by the general secretaries and the treasurer, with the technical members of the council as auxiliaries; these gentlemen are always chosen from the most eminent scientific talent of the country, and they constitute a body even more exclusive than the council of the Royal Society. None will doubt the thoroughly representative composition of the council, or that its members are doing less than their very best to promote the objects of the Association.

No executive body intervenes between the council and the sectional committees, and the latter meet only to settle the details of sectional procedure at the annual meeting; the general committee is merely a confirming body. In this detail of organisation seems to reside a notable defect. We should probably progress more rapidly if an intermediate set of men, chosen from among the more promising and active of the junior scientific men, were appointed to enunciate questions of policy, of initiative, and of action, and to put a definite scheme for each annual meeting before the council. The president-elect might act as chairman of this advisory body.

The council, meeting several times a year, cannot itself produce such a scheme. Its members are men who have filled most public offices in their respective professions and are distracted by a thousand calls upon their thought and time; they can, however, bring experience to bear towards amending and perfecting a well-thought-out plan of campaign laid before them.

The presentation of papers to sections as to an ordinary scientific society should, I venture to think, be definitely discouraged. The morning session of each section would be better occupied by a discussion upon some topic of immediate interest to the subject concerned; most large topics concern several sections of the Association, and these should amalgamate for a mutual exchange of views. If this mode of working were adopted as a general, rather than as an exceptional, practice, we should be spared audiences numbering about a dozen suffering under the vagaries of a lantern dimly burning.

The real feature of the meeting might well be made the delivery of semi-popular addresses by competent people on subjects of general interest. I have seen British Association evening lecturers, great authorities on their own subjects, but incapable of making themselves heard to a company outnumbering twenty, grappling with an audience of several thousands; the comments of these non-auditors have informed me of the extent to which such an exhibition promotes the objects of the British Association, and I can imagine the torments of the lecturer. One episode of this kind —it did not occur this year—does so much harm to science as to counterbalance the good results accruing from a dozen British Association meetings, and its recurrence should be made impossible. No professional class is, on the average, so competent to expound a good case as is that of the scientific man; anyone who has been in the habit of attending the Friday evening discourses at the Royal Institution will realise that this is a true statement. No class but ours, however, would commit the folly of inviting an incompetent exponent, of no matter what eminence, to address a general audience in the name of the community at large.

Dr. R. V. Stanford's view, that we ought to go to the British Association with a programme of fifty addresses to the non-scientific public, is, I believe, entirely sound. Such a programme could have been carried out at Cardiff; there were many present who combine high scientific achievement with marked expository power, but, apart from delivering themselves of a few impromptu remarks before sparse sectional attendances, these gentlemen perforce confined themselves to the object of their journey to Cardiff, and, like all the rest of us, thoroughly enjoyed their annual chat about scientific affairs with the many friends whom they had not seen since the meeting at Bournemouth last year.

If it be possible to construct such an aggressive plan of campaign as is foreshadowed by Dr. Stanford, some concrete object of attack must be selected. The following is merely a suggestion.

We are meeting next year in the intellectual centre of Scotland, in the capital town of a vast number of public-spirited and wealthy people. The University of Edinburgh is making a great effort to extend its science schools so as to bring them into line with present-day requirements. The objects of the Association would be well served by an intensive educational propaganda for the purpose of bringing home to wealthy Scotsmen what humanity, science, and the British Empire have to gain by the extension of liberal financial support to the University of Edinburgh.

WILLIAM J. POPE.

The Chemical Laboratory, University of Cambridge, September 20.

I CERTAINLY agree in the main with the views expressed in the leading article in NATURE of September 16 on "The British Association and National Life." No one seems to be satisfied with the Association as it is, and the advance of the times has left it decadent just when it ought to be entering into its heritage. Any detailed criticism of the last meeting could scarcely fail to be invidious, but it could have given to few the impression that scientific men themselves are aware of the position science now holds in the community or realise that the vast body of the general public, disillusioned by the war, looks to them to provide a way of escape from the evils that threaten our civilisation. The Association provides an annual opportunity to honour by rotation and seniority a few scientific men by making them officials and inviting them to preside over its deliberations; to advance the numerous schemes competing for public money one or two at a time; to study human nature, another city and the surrounding scenery; but it makes no attempt to come to grips with the real enemy or to take the position already conceded by the general public to the spirit and service of science as almost the only disinterested and effective agency in a cannibalistic and corrupt society.

Surely ever so much more now than in 1831, when the Association started and when the broader implications of scientific discovery and thought upon human life were not dreamt of, is there need for an Association to insist upon a greater degree of national attention to the objects of science, and, it may be added, to its long over-ripe fruits neglected in order that everything old and out-of-date may be scrupulously retained. It is not too much to say that whole fields of government in the real sense, which is not the conventional sense of party politics, now fall wholly within the ascertained realm of science. A remark of Mr. H. G. Wells from his "Outline of History" concerning ethnologists, geographers, and sociologists may be generalised. All the monstrous turmoil and waste, the wonderful attitudes, deeds, and schemes of the "great men" deemed famous by the unscientific historian, might very well be avoided if Europe had the sense to instruct a small body of ordinarily honest scientific men to take over the work.

Whether the British Association can be of any real help in enforcing proper respect for the public position of science or not, it is clear enough to the man in the street that figs are not gathered from thorns. When he wants his appendix removed he does not brief an advocate to get up the subject for his particular case to persuade him that he has not got an appendix or, if he has, that it would kill him to have it removed. Neither are the national appendices rendered less painful by the men who talk of them as the essential parts of the British Constitution, which, with their felicitous assumption of office, has at length reached its final and perfect expression. The public, if not scientific men, know that scientific government is inconceivable without scientific men at the head of affairs.

It is amazing that, as in the example of the director of research to the Glass Research Association, science should be served by men with less respect for science and understanding of its powers apparently than the ordinary common-sense citizen. The peculiar thing is that one may attend learned societies and British Association meetings regularly without taking any part in the important work of selecting the officials, who apparently descend upon them in some mysterious fashion from heaven.

Unless the British Association becomes democratic and acts as a real bond of union between scientific men and the thinking public, rather than as a periodic platform for personages, it does not seem to fulfil any function worth continuing. The public application of science is a totally different thing from applied science. This scientific synthesis and the direction of the unique mental attitude, induced only by the actual discovery of new knowledge, to the conduct of public affairs are the real and peculiar functions of the Association if it is to regain its national position. Curved space, isotopes, and the economics of life on the floor of the ocean are topics of great interest to hundreds of the public. The standards of truth which science has set up, and the elevation of its pursuit above sophistry, chicanery, and the monotonous motives of self-interest, inspire the imagination of hundreds of thousands. The British Association seems to be attacked by senile paralysis just as a belief in science and in the power of its methods is arising in the world phœnix-like from the ashes of its old self.

FREDERICK SODDY.

THE interesting criticism by Dr. R. V. Stanford in NATURE of September 2 tempted me to write. Your leading article of September 16 makes me yield to the temptation. There are two lines on which comment may run: broad and narrow gauge. Taking the broad or general view first, we have to appreciate the fact that the changed attitude of the public to the Association is part of a widespread change in social life. Science is more taught in our schools, elementary scholars and others are introduced to it in our museums, and yet the number of keen naturalists in our local societies is decreasing, and the help of amateurs is a diminishing quantity. The opportunity of the war period and the subsequent economic pressure have driven all but a few to earn their living. Those really interested in science become professional workers therein; the others pass into their own special professions. Consequently, a body like the British Association has to rely more on professed workers in science and less on the amateurs and "camp followers," whose attendance the *Times* actually deprecates. But of the scientific workers many have had their fill at the end of a year's work, not to mention the society and committee meetings that accompany it. All they want is a holiday, and one as remote as possible from their daily avocation and surroundings.

Here we switch on to the narrow gauge. If you hold a meeting in August when one man is on the moors, another sea-bathing off the Land's End, and a third climbing the Alps, can you expect them to go to Cardiff? An attempt to facilitate the attendance of junior students was on the right lines and in harmony with the general trend; we may hope for a better response at a more convenient season. The local naturalists played up all right, but the other inhabitants were more interested in the tram strike and the coal strike than in hearing about aeroplanes or a grain of wheat, and so Sir Richard Glazebrook and Sir Daniel Hall delivered their popular lectures to benches two-thirds empty. Possibly Cardiff is more concerned with shipping than with aviation and agriculture. Again, the mid-week meeting, now tried for two years, seems less convenient than the old system.

Now for the sections. It is difficult to suggest practicable reforms. If you restrict the papers to popular expositions you may have the president and his faithful recorder confined to listen to what they know already, while the other constituents of the section flit dispersedly round other rooms. You ought to give the local workers a chance, anyhow; and there will always be a few people who wish to test some novelty on an audience of experts. How would it do to have one day for the more technical papers, one day for inter-sectional meetings, one day for broader expositions, and one day for the president's address, reports of committees, and what may be called scientific politics? These days should differ for the different sections, and certainly all the sectional presidents should not be addressing at the same hour. The Oxford Parliament of Recorders, held this year, effected some admirable arrangements on these lines, though the printing of the Journal beforehand set an ideal before sectional officers which they could not always live up to—and hence confusion to the public. Yet another suggestion comes from a camp-follower. Why not have "Section X, Popular Science," in continuous session, with a jolly president, a lantern that will work, and as many "star" performers as you can get? I think there's something in that. Of course, it must be properly advertised, and with figures more attractive than the aged dodderer who symbolises science for the Cardiff School of Art.

F. A. BATHER.

I WAS very glad to see the leading article in NATURE of September 16. You have directed attention with great force and point to the need for altering the methods of the British Association if its meetings are to retain the interest and attention of the public.

I doubt if at any time there existed a larger number of persons interested in science and with a keen appreciation of the practical value of science to mankind. But the excessive specialisation of British Association meetings has repelled instead of attracting their interest, and they have felt that they could not "see the wood for the trees."

After all, as you point out, one of the most important functions of the Association is to obtain the attention of the nation to the objects of science. It cannot do this unless it is willing to popularise its meetings, and I feel sure that your suggestions to associate with the meetings public men, whether of local or national distinction, and by grouping sections to obtain a broader outlook upon the scientific questions of the day, form a practical contribution towards the problem of how to revive public interest in the Association. I trust they will be seriously considered by the council. NEVILLE CHAMBERLAIN.

Westbourne, Edgbaston, Birmingham,
September 20.

THE stress laid in the leading article in NATURE of September 16 on "The British Association and National Life" on the importance of the "enlightenment of an extensive group of workers as to main lines of advance in fields not specifically their own" emboldens me to repeat a suggestion which I have often made and never found acceptable. It is that the presidential addresses in the sections should be placed in the foreground of the work of the Association, and so timed that an individual member could hear them all if he felt so disposed. The president of a section may safely be assumed to know his own subject, and he is usually able to express his views in language sufficiently explicit to be clear to everyone interested in any department of science. It is of vital importance to every scientific worker to know how his brethren are heading, were it only in order to see which lines are converging on his own, and which in the light of new knowledge may seem to be diverging from it. HUGH ROBERT MILL.

September 18.

I WISH, as a mere layman, to support the plea in your leading article of September 16 for more energetic and *popular* action by the British Association.

I am afraid that the responsibility both for the indifference, or even hostility, to science of Governments (of which Prof. Soddy complained in a recent letter), and for the lack of financial support from the general public, lies at the door of men of science themselves, who do not understand that they ought to carry on systematic educational propaganda as to the value of science in terms of the things that interest the ordinary man.

I will give three pieces of evidence:

(1) I am thirty-four years of age. I have never been directly appealed to for a subscription to any scientific society, and I have never been asked to join one.

(2) I have just recently looked through the file containing letters appealing for subscriptions addressed to a certain business firm during the twelve months ended August 31, 1920. I find there are just over 150 appeals, or say three a week. They range from hospitals to choral societies. Not one is for aid to scientific research. Most exceptionally, there is one for an educational institution, and part of the large gift made in response *may* go to research.

(3) I happened to remark to a well-educated and intelligent man who takes great interest in public affairs that I was glad to see that a large sum of money had been given for biochemistry. My friend replied that no doubt it was a good thing, but he was sorry that the donor had not rather given the money to reduce the National Debt! I think I managed to convince him that the money given to biochemistry would probably yield the nation thousands per cent. in mere cash, to say nothing of other benefits, *e.g.* health.

But this is what the average man—very naturally—thinks of scientific research, and will continue to think until men of science, or more properly their officials specially trained for the work, carry on systematic propaganda in the same way as hospitals, political organisations, and trade bodies do.

The love of science for its own sake is a special taste, like an interest in heraldry or stamp-collecting. If the men of science want the support of those who do not happen to share that taste, they must show the non-scientific man that science (unlike stamp-collecting) can confer real benefits, moral or material, on the world at large.

Governments move as they are pushed; if they have not moved to support scientific research, it is because there is no strong body of public opinion pushing them.

My practical suggestions are these:

Creation of a "Propaganda and Finance Department" of the British Association, with a permanent staff consisting of a director (responsible to the council of the B.A.); under him a publicity manager controlling a staff of journalists and a staff of lecturers, a financial agent controlling a staff of travelling collectors, with the necessary typists and clerks.

The working would be somewhat as follows: The publicity manager tells his journalists to "write up" the life and experiments of Faraday, showing the present results; particulars of the industries and benefits that have resulted from them; number of men employed; dividends paids; number of tramcars running; and need of financial support for "our modern Faradays." This to be embodied in (i) lectures—for the travelling lecturers; (ii) posters; (iii) booklets and pamphlets for the use of the travelling collectors; and (iv) letters to the Press, especially the provincial and local Press.

After a certain district had been well "treated" with this propaganda, a travelling collector to be sent to interview individuals, firms, chambers of commerce, trade unions, and so on. These collectors would have to be men of high capacity and tact. They would endeavour to get (1) subscriptions and (2) new members of the B.A.

A few thousands a year spent in this way would produce easily an income of 500,000*l.* a year in subscriptions and donations, to say nothing of the other advantages that would flow in.

One useful means of propaganda would be a "Science Day" on the lines of Lifeboat Saturday. Another would be a "Review of the Year's Work" in each branch of science in non-technical language.

FRANK R. EAST.

9 King Edward's Road, Swansea,
September 18.

Relativity.

THE examples considered by the theory of relativity appear to have become somewhat stereotyped, and to deal mainly with problems of optics and electrodynamics. The specification of "simultaneity" seems to be regarded as necessarily involving the use of rays of light. The following suggested examples may perhaps be of interest. They are not put forward as possible "objections" to the theory, but with the same intention as prompted the supposed "exceptions" to the second law of thermodynamics. The latter, although they did not disturb the application of the law in its proper sphere, led to drastic limitations to its general validity (*e.g.* the "sorting demons" of Maxwell).

Consider first a cube of unit volume, constructed of rigid material absolutely impervious to heat. Suppose the cube contains a gas the temperature of which, measured by an observer rigidly attached to the box, is T. What will be the temperature as measured by another observer moving relative to the first with a uniform velocity v in the direction of one of the edges of the cube? The volume of the cube as measured by the second observer will, according to the theory of relativity, be reduced to $1/\sqrt{1-v^2/c^2}$. If the same laws hold for the gas for both observers, the temperature of the gas would seem to be $T(\sqrt{1-v^2/c^2})^{\gamma-1}$. We note in passing that this depends on γ, the ratio of specific heats, and thus on the structure of each of a definite number of molecules of gas contained in the cube. If the gas is supposed to be the mixture $2HI \rightleftharpoons H_2+I_2$, the extent of dissociation depends only on the temperature and not on the volume, and could be measured by the change in intensity of a beam of light passed through the box in a direction at right angles to its motion, and received by the second observer. The consideration of the case in which the cube is at rest and the second observer in motion would naturally follow. The detailed consideration of this case would appear to involve the transformation of the statistical equations for the energy and entropy of the gas in terms of the position and momentum co-ordinates of the molecules, but I must defer detailed discussion of this matter at the moment.

In the next case we will consider a possible definition of "simultaneity" not involving the use of rays of light. A chemical reaction taking place with a measurable velocity in a given position as measured by an observer at rest is employed. A solution is divided into two equal parts. One remains with the observer at rest, the other is taken by a second observer anywhere he pleases. When an event occurs simultaneously with respect to the two observers the chemical reaction is stopped and the solutions are brought back to the original position and analysed. Let us say that if equal amounts of substance have been changed the events were simultaneous. What objection is raised to this definition? As a further case, we may consider both observers provided with equal weights of radium, and instructed to measure time by counting the number of α-particles emitted from a given instant. This change is found by experiment to be independent of external conditions. If we assume the use of rays of light as a standard method, it follows that the rate of disintegration (and the rate of a chemical reaction) will depend on the velocity. A possibility of testing this by experiment with a centrifugal machine at once suggests itself. I find by calculation, however, that according to the theory of relativity the rate of emission of α-particles would not, in the most favourable circumstances, be changed by more than about one particle per second per gram of radium (see also A. H. Compton, *Phil. Mag.*, 1920, vol. xxxix., p. 659).

Attention may perhaps be directed to the calculation of Bucherer (*Physikal. Zeitsch.*, 1920, vol. xxi., p. 451), who shows that the displacement of spectrum lines may be calculated without the assumption of a general theory of relativity from the principles of thermodynamics. The deflection of light by the sun may yet be shown to depend on the condensation of æther—a hypothesis first put forward by Newton (Boyle's "Works," ed. by Birch, 1744, vol. i.). Neither of these tests appears to be crucial.

The possibility of an upper limit of temperature, when a particle attains by thermal processes a velocity c, is complicated by the change of mass with velocity. In the case of electrons it is further complicated by the doubt as to whether they can be set in motion at all by thermal means, which follows from the values of the specific heats of metals at low temperatures.

J. R. PARTINGTON.

East London College.

Variations of Eucalyptus Foliage.

THE eucalyptus tree is a common object in the gardens of Torquay, where it grows freely, though subject to having its tender branch-ends killed occasionally by frost-laden winds. In the King's Gardens here there are two of these trees of the same age which are remarkable for the contrast in the appearance and character of their foliage. One is bearing almost entirely long scimitar-shaped leaves that are petiolate and grow alternately on the branches with that pendulous habit which so characterises these plants. Its companion has a more robust appearance, and bears only the more or less elongated heart-shaped leaves that are erect, opposite, and sessile, with more of the grey-blue gummy exudation that gives them the common name of blue gum trees. It has been noticed that this plant had lost its leading shoot when very young, so that its mass is formed of branches grown from lateral buds. A few trunk shoots have appeared this season among the lower branches on the northern side of the companion tree first mentioned that bear the opposite, sessile leaves characteristic of the young plants, and a recently pollarded tree in a private garden near has developed two shoots from apparently the same lateral bud on the north side of the tree, that bear respectively the two forms of foliage, while a sheltered and uninjured tree in the Terrace Gardens of some 30 ft. in height has only the pendulous type of leaf upon it.

These observations, while bringing to notice a remarkable instance of reversion to seedling or ancestral characters, seem to indicate that with these plants light and temperature under the effects of injury influence their development relative to temporary or permanent reversion.

HARFORD J. LOWE.

The Museum, Torquay.

Old Road Maps.

THE reference in NATURE of September 16, p. 90, to John Cary's old road map prompts me to send particulars of an old and rare book, "A Pocket-Guide to the English Traveller: Being a Compleat Survey and Admeasurement of all the principal Roads and most considerable cross Roads in England and Wales," by Thomas Gardner, 1719. There are one hundred copper-plate engravings showing the roads, with the bridges, woods, inns, churches, beacons, gallows, etc., passed *en route*. The scale is, for the actual roads, about one inch to the mile, and every mile is numbered. This book has been in my possession for more than forty years, and I have never met anyone who has seen another copy. It is dedicated to "His Most Serene Majesty George, King of Great Britain, France and Ireland, etc."

C. CARUS-WILSON.

September 17.

The Electrical Transmission of Pictures.

By PHILIP R. COURSEY.

THE art of the transmission of a picture or drawing by electrical means from a given place, so that it can be reproduced in another, may, speaking generally, be said to date from the perfection of Bain's early chemical telegraph about 1842. In its original form Bain's apparatus was devised for purely telegraphic purposes for the reproduction of the given message at the distant station: with this in view, the message was set up in metal type at the transmitting station, and was connected up with a battery, a number of metallic contact brushes, and a series of line wires between the two stations, so that by moving the brushes across the metallic letters a series of electrical impulses was sent out along the various wires, depending upon the form and arrangement of the letters. At the receiving station a similar series of metallic brushes was passed over the surface of a paper strip, soaked in a solution of potassium iodide in starch, with the result that whenever a brush at the transmitter rested upon a metallic part of a letter a current flowed through the corresponding line and through the wet paper strip at the receiver, decomposing the KI solution and giving a blue stain through the reaction of the free iodine with the starch. The resultant marks therefore corresponded with the form of the letters arranged at the transmitting station.

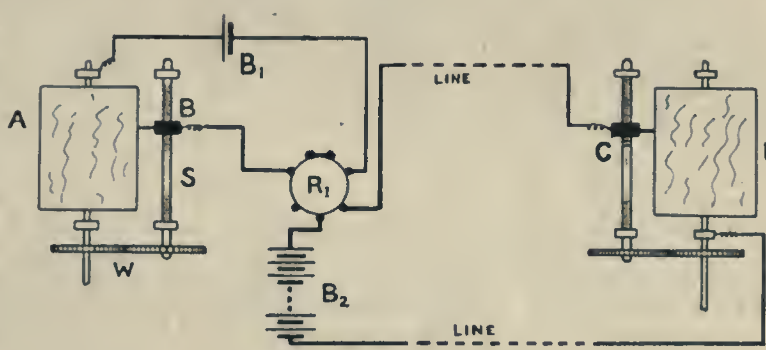

FIG. 1.

A very slight modification of this simple apparatus would enable it to be employed for the reproduction at a distant place of any sketch or line drawing, and, in fact, also of any picture or photograph not having too fine detail. In the case of a photograph, the reproduction at the receiving station would resemble a print from a block of the picture made with a rather coarse screen. This "screen" in the resultant reproduction constitutes the most serious limitation in the quality of the work produced by any of the known methods of photography, and no very obvious way of overcoming this defect is yet apparent. It may be minimised by accurate mechanical construction of the transmitting and receiving mechanism, and by enlarging the original picture photographically before transmission, so that subsequent reduction of the received reproduction will render the screen less noticeable.

The apparatus might be arranged somewhat as indicated diagrammatically in Fig. 1. A cylindrical drum A is fitted with a small contact brush B electrically insulated from, but moved by, the fine pitch screw S, geared by the wheels W to the axis of A. The brush B, therefore, traces out a spiral path on the surface of A when the drum is rotated. At the receiving station, an exactly similar drum D and contact C are provided, the two being electrically connected together through the line wires. Each cylinder is provided with a driving mechanism—of clockwork or other convenient motor—and some governing mechanism to maintain a constant speed. Exact synchronism between the two cylinders is essential if an accurate reproduction is to be obtained. Uniform driving is therefore necessary unless arrangements are made for synchronisation at the beginning of each revolution by means of a special synchronising impulse between the two stations. A phonic wheel, or some similar motor, may be employed with advantage.

For transmitting the impulses to the line wires with such an arrangement as that outlined above, the original picture may be reproduced in metal by an ordinary block-making process, and attached to the cylinder A. Contact will therefore be made with the brush B, as the cylinder revolves, at all points which would mark the paper were the same block used for ordinary printing. For the reproduction at the receiver an electrolytic arrangement similar to that of the original Bain telegraph may be employed, using potassium iodide and starch for the electrolyte, or potassium ferrocyanide with an iron electrode brush C.

This apparatus in its simple form is evidently suitable only for reproducing sketches or drawings of which ordinary line blocks can be prepared, but with an improved receiver, such, for example, as the photographic one described below, a "half-tone" block made from a photograph could evidently be used, if the screen were not too fine. For satisfactory reproduction the travel of the brush B per revolution of A should be equal to the distance between the screen lines.

The repeating relay R may be placed when required between the transmitter and the lines to enable smaller control currents to be employed. A similar relay may be placed at the receiving end, if the incoming current is too weak.

As an alternative to making a metal reproduction of the original picture for transmission by this method, a photograph of the original may be printed on to a sensitised gelatine film on the metal cylinder A, and the parts unaffected by light washed away to leave the metal exposed, so that contact may be made with the brush B.

One of the best known practical developments of photo-telegraphy was made by Dr. Korn some twelve years ago. In his apparatus the original picture was photographed on to a transparent film, which was then wrapped round the cylinder A—in this case made of glass. Instead of the contact brush B, a fine pencil of light was used, which, after passing through the film, fell on a sensitive selenium cell and thus modulated the current flowing out to the lines in accordance with the opacity of the film. At the receiver the incoming current was passed through a special form of galvanometer—practically a double-thread Einthoven galvanometer—so that a light aluminium shutter was moved aside to a greater or less extent, depending upon the strength of the current. A beam of light was thus controlled in intensity before falling upon a sensitive film attached to the receiving drum D. The path traced out by this beam followed a spiral track on the surface of D, as in the case of the brush C of the arrangement of Fig. 1, and similar governing or synchronising arrangements were of course required.

A photographic recorder of this type possesses considerable advantages over the simple electrolytic arrangement outlined at first, and enables much more accurate work to be accomplished. It is obviously not the only possible arrangement to obtain the desired result, but, although differing in detail, the other varieties that have been used operate upon similar principles.

The chief disadvantage of the selenium-cell modulator at the transmitting station is to be found in its inertia to rapid changes of illumination, with the consequent limitation of the speed of operation. In the practical apparatus a compensation arrangement was employed to increase the speed of transmission, but better results would be possible with a light sensitive material having less lag. Some of the more recently discovered sensitive materials may prove better in this respect.

An ingenious alternative transmitter has recently been put to practical test. The photographic print of the original picture at the transmitter is made in gelatine or similar material, giving a relief print when "developed." Instead of passing a metallic contact over such a print, a needle is used in such a manner that difference in relief varies the resistance of a microphonic contact, and thus controls the line current. The reproduction at the receiving station is effected with a photographic apparatus of the type described above.

From the transmission of pictures by wire, it is but a relatively small step to their transmission by radio. In the earlier stages of wireless development attempts were made in this direction with more or less success, but the irregularities of the coherer, which was at that time the only receiver capable of controlling sufficient local energy to operate the recording apparatus, prevented the practical development of the method. With the modern three-electrode valve receivers and relays this difficulty is removed, and their use at the transmitting station as continuous-wave generators is also advantageous. Considerable developments on these lines may therefore be expected in the near future. In particular the last described transmitter, with microphonic control, should be especially easily adaptable to radio work by using any one of the well-known radio-telephone modulation methods.

During the last few months some considerable interest has been aroused by a method of photograph transmission applicable to either wire, cable, or wireless signalling. Strictly speaking, however, this method is not of the same class as the above, in which the picture itself controls the actual signalling currents, as the transmission is effected by a series of code letters, words, or numbers, sent as an ordinary telegraphic message between the two stations. By this method the original picture is divided up into a number of small units, and a code letter used to designate the condition of light or shade in that unit, thus enabling a complete code message to be built up to represent the whole picture. At the receiving station the decoding may be effected in an obvious way, or a mechanical decoding machine may be employed to reproduce the picture.

The Structure of the Atom.[1]

By C. G. Darwin.

III.—*The Nucleus.*

IN the previous articles we discussed the nucleus mainly in connection with the idea of atomic number. We shall now return to the characters of the nucleus itself; but before doing so it is necessary to say something about the atom as a whole. Comparatively little is known about the electrons surrounding the nucleus—it is not even universally agreed whether they are at rest or in motion—but a successful beginning has been made by the Bohr spectrum theory, which applies mainly to the specially simple case of hydrogen. On the same lines Sommerfeld has also had some success with the X-ray spectra. It is quite certain, as in all questions of atomics, that the laws of classical dynamics do not hold, and the principal method in research at present consists in a judicious mixture of these laws with the quantum theory. This latter theory is definitely contradictory not only to the laws of mechanics, but also to almost any conceivable modification of them, and its chief justification, an entirely adequate one, is the astounding success with which it has

[1] Continued from p. 83

been extended over more and more branches of physics.

We shall not deal here with these spectroscopic questions, but it will be convenient to have a definite idea of the scale on which the atom is built. The proportions of its parts vary over so wide a range that no drawing can possibly represent them. We shall be dealing with magnitudes as small as 10^{-16} cm., and as these large negative indices convey little definite to the mind, it will be convenient in describing the atom to raise the whole scale by 10^{13}. On this scale 1 cm. would become a length about two-thirds of the distance from the earth to the sun. The outermost electrons of the atom would be about a kilometre from the nucleus, and for the heavier elements the innermost, perhaps three in number, would be roughly 10 metres from it. As to the nucleus itself, there is definite evidence that it is less than 30 cm. in radius, and, in some cases at any rate, that it is greater than 2 cm. Other physical quantities which we shall require are of a slightly more hypothetical nature. On the theory that all mass is electromagnetic, we can calculate the radius of an electron, since we know its charge and mass. This radius comes to about 2 cm. (actually $1{\cdot}88 \times 10^{-13}$ cm.). By a similar calculation the hydrogen nucleus has a radius of about one-hundredth of a millimetre. The same argument would make the radii of heavier nuclei about as small as this, but would not be justifiable, because, as we shall see, there is clear evidence that these nuclei owe their large mass to their being composite structures built up from hydrogen nuclei and electrons. From the extraordinary smallness of the quantities we have considered, it is not surprising that experiments with the nucleus should be very difficult. We now turn to these experiments.

When first describing the nucleus, in the first article, we saw that when an α-particle goes near it, it describes a calculable orbit, so that we can find a distance of closest approach between the two. As the predicted law of scattering was borne out by experiment, we can conclude that the law of force at this distance of closest approach (3×10^{-12} cm. for gold, above called 30 cm.) is still the inverse square law. Therefore the sum of the radii of the α-particle and the nucleus must be less than this. But a different case has been studied in great detail by Rutherford. Where the α-particles are passing through hydrogen, the repulsive forces between the nuclei are much weaker than for other substances, because the atomic number of hydrogen is only 1, and so the nuclei can get much closer together. But there is also another difference, for the hydrogen nucleus has mass only a quarter of that of the α-particle. Consequently, if there is a "straight on" collision the hydrogen is shot forward at a speed higher than that of the colliding α-particle, and the latter follows on behind with reduced speed. This new type of particle, the H-particle, then proceeds to traverse any matter in its path, losing speed in the same sort of way as does an α-particle, and it can be calculated that, whereas the fastest α-particles go through only 7 cm. of air, the fastest of these H-particles should go through 28 cm. (Fig. 2). Experiment bore out this prediction, but when the calculation was pushed further so as to show how many should go various distances from 28 cm. downwards, a very wide difference was found between theory and experiment. This indicates that there is something wrong with the theory—in fact, that the approach between the nuclei is so close that the ordinary law of repulsion fails. This ordinary law would give 2×10^{-13} cm. as the distance of closest approach, and we therefore conclude that the sum of the radii of the hydrogen and helium nuclei is greater than this. Now the radius of the electron is about 2×10^{-13} cm., and the coincidence of these two numbers tends to support the view that there are electrons in the nucleus of the helium atom.

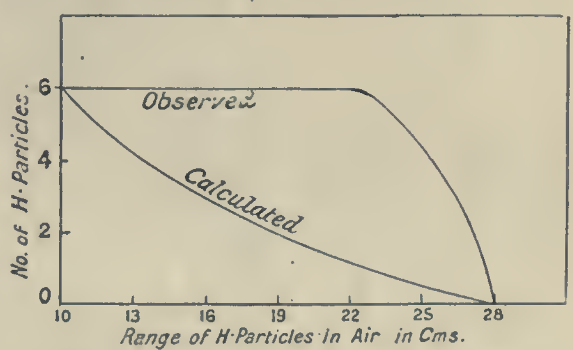

FIG. 2.—From Sir Ernest Rutherford's paper "The Collision of α-Particles with Light Atoms" (*Phil. Mag.*, xxxvii., p. 549). The wide difference between the "observed" and "calculated" curves shows that the assumed law of force between α-particle and H-nucleus is wrong; in fact, that a lower limit has been obtained to the size of the nucleus.

Turning now to the constitution of the nucleus, the first piece of information is provided by radioactivity. In successive radio-active transformations α- and β-particles are projected from the nucleus. Therefore the latter must contain both—that is, helium nuclei and electrons. Next we have the evidence from Rutherford's transmutation of elements. The experiments in which this occurred consisted in the bombardment of various elements by α-particles. When nitrogen was tried, he observed that a certain number of H-particles was obtained. As no hydrogen was present, we are compelled to conclude that these particles were knocked off the nuclei of the nitrogen atoms; so we can be confident that these nuclei contain hydrogen nuclei. In recent work Rutherford has got even further, for he has found another entirely new type of particle which is sometimes knocked off nitrogen and oxygen. These particles have atomic mass 3 and number 2, so that if they were obtained in bulk they would be helium of density 25 per cent. less than ordinary helium. It is at present unknown what happens to the remainder of the nucleus after these losses. A point of great interest in this work is that the new particles come off with greater energy than that of the bombarding α-particles. If we carry over the language of chemistry to this new domain we should say that the reaction is exothermic, and nitrogen in a metastable state.

We have so far discussed the special properties of particular elements. The next evidence is very much more general, and holds out great promise of extension. This is the recent work of Aston with the "positive rays." It was undertaken in order to detect whether ordinary elements were composed of isotopes. He found that this was true of the majority of those he examined (his numerical results are given in the table in the first article), but the important result from our present point of view is that in all his elements the atomic weight of each isotope was almost exactly an integer. This will be slightly qualified in the next paragraph. Aston has so far examined eighteen elements and found the rule true, and it is scarcely credible, therefore, that it should not be universal. But if so, it can only mean that all nuclei are constructed out of hydrogen nuclei. That would satisfy the conditions as to mass, and in order to make the atomic number correct we must then suppose that these hydrogen nuclei are cemented together by electrons. For example, chlorine has atomic number 17. Its atomic weight, determined chemically, is 35·5, and Aston finds that it is composed of two isotopes at 35 and 37. Therefore three-quarters of the chlorine atoms have nuclei composed of 35 hydrogen nuclei and 18 electrons, while for the remaining quarter the numbers are 37 and 20 respectively. This is the revived form of the famous hypothesis of Prout.

Aston's experiments have not hitherto been sufficiently accurate to detect any departures from the whole number rule, except in the case of hydrogen. In this case his work confirms the chemical result that the atomic weight is 1·008 instead of being 1. At first sight this would appear to dispose entirely of the validity of our interpretation of the whole number rule, but that is not so, and by the use of arguments based on the work of Einstein on relativity, the departure from whole numbers can be made to yield valuable information. Einstein's theory implies that all energy must have mass (and also that all mass must have weight). Thus the mass of a helium nucleus (at. no. 2 and at. wt. 4) will not be simply the sum of the masses of its four α-particles and two electrons, but will also include the mass of its energy of formation. As the helium is lighter than the sum of the weights of these particles, we conclude that this energy is negative—that is to say, an atom of helium has less energy than its separated particles. Lenz has calculated the difference and finds that it corresponds to the energy of about three of the fastest α-particles. So helium is an exceedingly stable substance, and it need create no surprise that its nuclei, when projected as α-particles, can undergo the most violent collisions without disruption. It also makes it not unnatural that in radio-active disintegration it is helium, and not hydrogen, that is emitted. Moreover, it is well known that the atomic weights of most elements are nearer whole numbers when helium is taken as standard at 4 than when hydrogen is taken as 1. This indicates that in most atoms the majority of the hydrogen nuclei are bound together in helium sub-groups.

It will thus be seen that a very promising beginning has been made in the study of the nucleus. We know that it is built up of hydrogen nuclei and electrons, and that there is a strong tendency to form helium sub-groups. We know the number of hydrogen nuclei and electrons in the nuclei of many of the elements, and may expect to know those of the majority at no distant date. Most encouraging of all, we may hope that it will not be very long before a definite theory of the structure of nuclei is made, based on exact knowledge of the energy of formation of the various elements.

Obituary.

THE RIGHT HON. SIR WILLIAM MATHER.

WE deeply regret to record the death of Sir William Mather, at his residence in the New Forest, on Saturday last, September 18. Sir William was born in Manchester in 1838, and educated at private schools, and his studies were continued under one of his English tutors at Dresden. Afterwards he entered his father's engineering firm, well known as the Salford Iron Works, and worked the usual hours of apprentices, in the evenings attending lectures at the Owens College, Manchester. In 1862, when he was twenty-four years of age, he became solely responsible for the management of the business. The firm enjoyed great repute as makers of bleaching, dyeing, finishing, and other textile machinery, exporting its products abroad, especially to Russia and the United States, in which countries Sir William travelled extensively. He took the greatest interest in the well-being of his employees, his firm being among the first to establish the eight hours' day, and providing for his young workers, more than forty years ago, the means of continued instruction in the fundamental principles of engineering science, at the hands of his chief technical officers, and with striking results, many of the students gaining Whitworth and other science scholarships.

Sir William Mather took a deep interest in local affairs and movements, was a member of the

Salford School Board for ten years, from 1872, and for a time on Salford Town Council. He also entered Parliament, where his intimate knowledge of industrial and educational matters proved of the greatest service. On the appointment of the Royal Commission of 1881 on technical education at home and abroad, the report of which did so much to direct the attention of the nation to its shortcomings in the means of education and training in science and its applications, Sir William Mather, because of his intimate experience of the conditions of industry in the United States and Russia, accepted the position of special commissioner in those countries and wrote two valuable reports which were included with that of the Royal Commission. The inquiries of this Commission undoubtedly led to the passing of the Technical Instruction Act of 1889 and to the subsequent Excise and Customs Act of 1890, by which a fund of 800,000*l*. was placed at the service of technical instruction.

Sir William Mather's intimate association with educational institutions in the United States, and his sympathy with the system of manual training prevailing there, enabled him to invite its chief exponent, Prof. Woodward, of St. Louis, to a conference in Manchester in 1882 on "Education under Healthy Conditions," with the result that there was established in the Manchester Mechanics' Institution the first manual training school in Great Britain. He gave to Chetham College (for orphan boys) in Manchester a complete manual training equipment, and likewise did the same service for the engineering department of the college at Khartoum, in the Sudan. He identified himself with all types of educational advance, founding in Manchester the Mather College for the training of kindergarten teachers, and taking a deep interest in the activities of the Union of Lancashire and Cheshire Institutes, of which he was president from 1908 until 1919, in connection with which he founded a valuable scholarship and exhibitions.

One of the chief features of the Franco-British Exhibition of 1908 was the fine display of British educational enterprise, which owed its initiation to Sir William Mather, and of which he bore the entire cost. The value of the exhibition was much enhanced by the addresses of eminent educationists whom he invited. He was a warm supporter of the British Science Guild, founded in 1905, and was its president from 1913 to 1917. He regarded it as "a body capable of development up to the rank of a powerful national institution permeating the industrial life of the Empire with the fruits of scientific research," and to it he gave the most liberal financial support. On the foundation of the Association of Technical Institutions he became its first president, and gave it effective aid in many ways. By Sir William Mather's death the causes of education and of scientific efficiency in industry suffer an almost irremediable loss. He was laid to rest on Wednesday in the grounds of Prestwich Parish Church, near Manchester.

THE death is announced, on August 19, at fifty-six years of age, of PROF. T. RIDLER DAVIES, associate professor of mathematics at McGill University, Montreal.

SIR WILLIAM BABTIE, V.C., who held many important posts in the Army Medical Service, died on September 11, in Belgium, where he was spending a holiday. Sir William was born in 1859 at Dumbarton, and was educated at Glasgow University, where he took his M.B. degree in 1880. In the same year he became L.R.C.P., L.R.C.S. of Edinburgh, and in the following year entered the Army Medical Service, of which he was made Deputy-Director-General in 1910. He retained this post until 1914, when he was appointed Director of Medical Services in India; later he filled the same office in the Mediterranean. He was created a K.C.M.G. in 1916 and a K.C.B. in 1919, and was known as an administrator rather than for his medical work.

SIR JAMES B. BALL, chief engineer of the London, Brighton, and South Coast Railway, who died suddenly on September 17, was born in 1867, and started as a railway engineer with the Great Northern Railway in 1890. He served with various companies until he became engineer-in-chief of the Great Central Railway in 1912, a post which he occupied until 1917, when he went to the London, Brighton, and South Coast Railway. During the latter part of the war, Sir James Ball was appointed Controller of Timber Supplies for the Board of Trade, and in 1918 he was knighted. He received the Telford gold medal of the Institution of Civil Engineers, and was the author of several technical papers communicated to that body. His work included the design and execution of many large-scale railway and dock enterprises.

SIR J. W. BYERS, one of the leading physicians of the North of Ireland, who died on September 20, was born in China in 1853, but was educated and spent his life in Belfast. He commenced practice in the Children's Hospital at Belfast in 1879, and in 1882 he took over the department for diseases of women in the Royal Victoria Hospital in that city. In 1896 he was elected honorary president of the International Congress of Obstetrics and Gynæcology. He was president of the Section of Obstetric Medicine and Gynæcology of the British Medical Association in 1901, and from 1902 to 1906 was a member of the council of that body. In 1907, Sir John Byers was president of the Section of Physical Education and Training in Personal Hygiene of the International Congress on School Hygiene, and in 1916 he was knighted. During his lifetime he took a prominent part in all movements concerned with public health, particularly those dealing with tuberculosis and infant mortality. He was the author of many medical works, and of some papers and a book on the folklore of Ulster.

Notes.

THE sixth International Congress of Mathematicians is being held this week at Strasbourg. It is eight years since the last congress was held at Cambridge, and it will be noted with regret that the then honorary president, Lord Rayleigh, and the president, Sir George Darwin, are no longer with us. The present meeting was fixed for this year at the Allied Conference of Scientific Societies held in Brussels in July, 1919; its organisation has been in the hands of the Comité National Français de Mathématique, of which M. Emile Picard is president, and of a local organising committee (president, M. Villat). On Wednesday, after the congress had been formally opened by M. Alapetite, Commissaire Général de la République, the members proceeded to elect their president and other officers. In the evening a reception was held by the organising committee in the Salle des Fêtes. In the course of the meeting lectures are being given by Sir Joseph Larmor (Thursday), Prof. L. E. Dickson (Friday), M. de la Vallée-Poussin (Saturday), M. Volterra (Tuesday morning next), and M. Nörlund (Tuesday afternoon). On Friday evening Gen. Taufflieb will give an address on "Science in Alsace." Conducted visits have been arranged to the cathedral and the museums, and excursions to the ports of Strasbourg and Kehl, to Saverne, and to Linge. At the end of the proceedings on Tuesday, September 28, the members will be entertained at a banquet kindly given by the organising committee. There is every prospect of a successful meeting, and it is anticipated that the members will have much of interest to communicate after being out of touch with each other for so long a period. On the eve of a new academic session English mathematicians are finding some difficulty in attending; only ten entries have so far been recorded from the United Kingdom.

SOME time ago the National Sea Fisheries Protection Association initiated a movement for the creation of a British Fisheries Society. A draft charter and by-laws have been prepared, and anyone interested in this matter can obtain a copy of the draft by-laws from Capt. G. C. L. Howell, Gadesprings, Hemel Hempstead. The proposal is to organise the society in two divisions, (1) industrial and (2) scientific, intelligence and general. Each division is organised in sections, fourteen in all, and these represent every interest in the fishery industry, producers, manufacturers, and distributors. Presumably the society as a whole will hold periodical meetings, and at these matters affecting the industry will be referred to the sections as committees. Proposals for a Journal, Transactions, and Proceedings, as well as for the institution of a library and museum, are outlined, and, in general, the objects of the society are to gather and diffuse information upon all matters relating to the fisheries and to unite all interests and affiliate the various bodies at present in existence. It is supported by a number of men very well known in the fishing industry.

WE have received notice of the forthcoming establishment in the University of Paris of an Institute of Psychology. The institute will be administered by a council composed of Profs. Delacroix, Dumas, Janet, Piéron, and Rabaud, and the Deans of the Faculty of Letters and Sciences. It will afford instruction, both theoretical and practical, in general, physiological, experimental, pathological, and comparative psychology. To it will be attached the recently established Institute of Pedagogy, forming its pedagogical section. Other sections of the institute, dealing with the general applications of psychology and with vocational selection, will be formed shortly. The institute will grant diplomas to successful students in each of these sections and to those who, after attending other courses of instruction, have passed the examinations therein. It will also be open for research work in connection with the University doctorate or higher diplomas. This union of Parisian psychologists can but strengthen the position of psychology in France. Previously Prof. Janet with his colleague, Prof. Dumas, worked in psychopathology quite independently of the late Alfred Binet, who directed the psychological laboratory. Prof. Piéron, Binet's successor, is now joining forces with the most famous representatives of French pathological psychology, and the institute thus formed is also to encourage the applications of psychology to education and to industry. The institute deserves to achieve success, and it has our best wishes.

A SUMMARY of the weather for the summer season, comprised by the thirteen weeks from May 30 to August 28, is given in the Weekly Weather Report of the Meteorological Office for the week ending August 28. The absolute highest shade temperature for the whole of the British Isles was 81° F. in Scotland E. and the Midland Counties, whilst in seven out of the twelve districts into which the country is divided the temperature failed to touch 80°, the highest temperature in England S.W. being 75° and in the English Channel 73°. Frost was registered in three of the five eastern districts. The mean temperature for the summer was below the average over the whole of the British Isles, the difference ranging from 0·5° F. in Scotland N. to 1·6° in one-half of the eastern and western districts. The essential feature of the summer was the persistent cool weather, and particularly the absence of warm days. At Greenwich the coldest of the three summer months was August, with a mean temperature of 58·7°, which is 4·2° below the average for seventy years, and there were only eleven days with the thermometer 70° or above against an average of twenty-one days. August of 1912 was slightly cooler, but this is the only exception since 1841. The mean temperature for the whole summer at Greenwich was 60°, which is 2° colder than the normal. The Meteorological Office record for the summer shows that the amount of rain was in excess of the normal except in Scotland N., England E., and Ireland. The greatest excess was 1·85 in. over the north-west of England and 1·77 in. over the south-east of England. The highest total fall was 11·77 in. for Scotland W., the least 6·25 in. for England E. July was generally the wettest summer month. The duration of bright sunshine was less than the normal except in Scotland N. and E.

THE annual exhibition of the Royal Photographic Society is being held at the society's house, 35 Russell Square, W.C.1, and will remain open until the end of October. It is divided into three sections, namely, pictorial photographs, colour transparencies, and scientific and technical exhibits. The last is exceptionally rich in radiographic and astronomical photographs. Mr. Luboshez has a room to himself in which he shows several series of X-ray negatives on "Eastman duplitized film," made to find the methods of getting the best results in normal and adverse circumstances. The Sunic Research Laboratory shows radiographs of iron and steel welds, a carbon block, and a Palmer aero tyre, besides a "radiometallograph of thumb," which shows the lines and dots of the skin with great clearness. The other radiographs include a fine series by Dr. Robert Knox. The Astronomer Royal sends series of photographs of the total eclipse of the sun in 1919, the great sun-spot of March, 1920, and the new star in Cygnus. A number of fine photographs of the moon and two of the sun is contributed by the Mount Wilson Observatory. The research laboratory of the Eastman Kodak Co. sends some very interesting experimental results. There is a large number of natural history subjects. Some of the most notable are the president's coal-plant fossils; a tree in California which is supposed to be the oldest living thing, as it was a sturdy tree when Moses was a boy, contributed by the National Geographic Society of Washington; and Mr. Hugh Main's studies of the metamorphoses of beetles and other insects which take place underground, obtained by means of his "Subterrarium." Mr. Alfred E. Tonge sends sixty photomicrographs of the ova of British butterflies, including every genus as enumerated in "The Butterflies of the British Isles," and there are other photographs of entomological, botanical, geographical, zoological, and mathematical interest, besides some excellent aeroplane photographs by Capt. F. R. Logan.

THE annual meeting of the British Mycological Society will be held at Minehead from September 27 to October 2. On Wednesday, September 29, Mr. T. Petch will deliver his presidential address on "Fungi Parasitic on Scale Insects." There will be excursions each day, and in the evenings of September 30 and October 1 the following papers will be read:—The Action of Gravity on the Fungi, Dr. Harold Wager; The Genus Ganoderma (Karst), Pat, Carleton Rea; The Mycorhiza of Orchids, J. Ramsbottom; The Audibility of the "Puffing" in the Larger Discomycetes, Prof. A. H. R. Buller; and The Sporulating Gonidia of *Evernia prunastri*, Ach., R. Paulson.

PROF. A. D. WALLER, who went by a Handley Page open aeroplane to Brussels on Friday, September 10, has sent home the following notes, which are of interest as giving details of times, etc.:—"Started 2.45 p.m., arrived Brussels 4.40. Misty over London. England very puzzling. Thames distinct. 2.55.—Sea in sight. 3.15.—Left England. 3.20.—Lovely white coast; sun and steamers. Bar. 3000 ft., 95 m.p.h. 3.23.—Marvellous view of both coasts. 3.33.—Arrive France (Calais). 3.47.—Dunkerque. 3.55.—Nieuport and scarred battlefield zone. 4.2.—Dixmude. 4.16.—Ghent. 4.24.—Approaching Brussels. 4.32.—Brussels on horizon (3000 ft.). 4.34.—Are we visible? 4.40.—Gently land."

MR. J. HORNELL produces in the September issue of *Man* new evidence to prove the common origin of the outrigger canoes of Madagascar and East Africa. From these we have evidence of a remarkable case of culture transmission. It is now clear that the dominant Madagascar form is so closely related to that of North Java that we may regard them as identical. It follows, then, that the East African forms are all varieties of the Madagascar model, that the vertical stanchion design of African outriggers is more primitive than the oblique, and that the resemblance of this oblique form of stanchion to certain widely distributed Indonesian types of oblique connecting-joints (modified stanchions) in Bali, the Celebes, and the Moluccas is an instance of convergence and of independent origin.

THE recently established Archæological Department in the dominions of his Exalted Highness the Nizam of Hyderabad is doing excellent service to the study of Indian antiquities. The report of the survey for 1917–18, recently issued, describes the progress made in the inspection of monuments. Every cave of the important Ajanta series is now in good order, and only some minor improvements remain to be made. In co-operation with Sir John Marshall, director of the Imperial Indian Survey, arrangements have been made to bring out an expert from Italy to examine the frescoes and to suggest measures to save them from further decay, while it is contemplated, under a scheme worked out by Sir John Marshall, in consultation with Sir Aurel Stein and M. Foucher, to have them reproduced by the three-colour process. Large collections of inscriptions have been made, and Mr. T. Srinivas, curator of the Hyderabad Museum, was deputed to inspect various other museums in India and to arrange for the exhibition of the Hyderabad collections. It is much to be desired that the other Native States in India, particularly those of Central India and Rajputana, should follow the example thus set by H.H. the Nizam of Hyderabad.

AN address in memory of Pasteur's residence there was delivered at Strasbourg on July 26 by M. Calmette at the Congress of the French Association for the Advancement of Science. The subject was "Ultramicroscopic Micro-organisms." After a description of the salient features connected with many of these organisms, M. Calmette referred to the difficulty of obtaining filter-candles and membranes having a constant and homogeneous texture. Besides their invisibility and filterability, these ultramicroscopic organisms present certain common features. They are all destroyed at a comparatively low temperature and by weak solutions of most disinfectants. On the other hand, they maintain their vitality for a considerable time in pure glycerin. They are infectious only by direct contact or by inoculation, and never by water, air, soil, or fomites. The pathological lesions are also similar, and characterised by cell-"inclusions" and alterations of the cell-nuclei.

A TYPICAL instance of the deplorable methods of the "oologist" is given in the September issue of *British Birds* by Mr. Thomas Lewis, who set himself the task of recording the breeding habits of a colony of lesser terns newly established last year "on the southern part of the Norfolk coast." At one period there were more than forty nests on the beach. Then, on June 19, the colony "was almost completely destroyed by an egg-collector who swept three-fourths of the eggs, most of them far gone in incubation and some actually chipping, from the beach." Instances of this kind are, unhappily, far too common, and while this state of affairs continues the "oologists" can scarcely complain when they are reminded that between "egg-collecting" and scientific ornithology there is a wide gulf. This abominable raid made a complete survey of the breeding habits of this bird impossible; but the author fortunately succeeded in making a series of very valuable observations on the courtship and incubation periods, and in taking a number of remarkably fine photographs which accompany his essay.

THE latest report of the Industrial Fatigue Research Board (No. 8), by Messrs. S. Wyatt and H. C. Weston, is concerned with a preliminary study of some of the problems connected with bobbin-winding. The authors give a description of the conditions prevailing in the bobbin-winding department of a mill where the owners are enlightened enough to appreciate the value of attention to labour-saving devices and to the welfare of the workers. It was found that the conditions of labour were generally satisfactory except for the length of one of the working periods, which was of four and a half hours; such a period is probably too long for monotonous work, and might advisably be broken up by rest-pauses. The marked individual differences in efficiency which were noticed suggest that a more careful selection of the workers would be advantageous. The liability to accidents was very slight and the labour wastage almost negligible, so neither of these could be utilised as data for fatigue. In so far as it was possible to use output as an indication of fatigue, no signs of undue fatigue were evident, although the authors are very careful to emphasise the complex nature of the processes involved, and therefore the difficulty of taking such negative results as final. Although the data obtained do not permit of generalisation, yet it is clear that before confident conclusions on the fatigue resulting from industrial conditions can be reached, very many studies of this nature extending over years must be made in this and other trades, so that an abundance of evidence may be available as a foundation for future work. Such reports are valuable as correctives to the tendency, only too noticeable at the present time, to use science unscientifically.

MR. W. H. DALL, in reviewing "Pliocene and Pleistocene Fossils from Alaska" (U.S. Geol. Surv., Prof. Paper 125-C, 1920), points out that evidence accumulates against the view of a late Cainozoic bridge whereby land animals could cross in the Bering Strait region from Asia to America. The ice of glacial times afforded the only admissible means of communication. The Pliocene fossils of England and Iceland, investigated by Mr. F. W. Harmer, indicate a more free connection than now exists between the Bering Sea and North Atlantic waters.

THE older rocks of Mysore are receiving detailed study from the State Department of Mines and Geology. In the Records of this Department, vol. xvii., p. 67 (1920), Mr. B. Jayaram shows how some of the limestones of Mysore have originated from the alteration of calciferous igneous bands, while many actually replace quartz-felspar rocks of the granite and gneiss series. In Bulletin No. 9 (1920), Mr. P. S. Iyengar treats of the acid rocks of the State in general. As in so many areas, the gneisses have proved to be younger than a schistose series (here the Dharwars), the relations being those already pointed out by Drs. Smeeth and Fermor over a wider field. Mr. Iyengar is firm, and we think thoroughly justified, in his assertion that the Peninsular gneiss is an intrusive rock that has replaced the formation invaded by it.

"THE Use of the Panoramic Camera in Topographical Surveying," by Mr. J. W. Bagley, is a useful publication of the United States Geological Survey (Bulletin 657). In comparison with other methods of survey, the panoramic camera has certain advantages. Its use reduces very considerably the time required to be spent at each station in a plane-table survey. It follows that in the case of reconnaissance surveys a larger number of stations and so greater detail are possible with the help of a panoramic camera than without it. It is also found that with this camera and the plane-table the topographer is better equipped for country of both high and low relief than with the theodolite and plate-camera. Considerations of weight owing to the use of films instead of plates, and of cost as reflected in speedier work, are claimed to show other advantages. Full details are given of the camera and the methods of using it. The largest scale of surveys in which this camera has been used is 1 : 48,000, but this is by no means the limit of its use, which is decided by the degree of accuracy necessary in determining elevations—that is, roughly, by the contour interval. The bulletin also contains some useful notes on the application of photogrammetry to aerial surveys.

MESSRS. NEGRETTI AND ZAMBRA, of Holborn Viaduct, have issued a catalogue and price-list of meteorological instruments. The publication is well illustrated, and a detailed description is given of the several instruments. Each section is prefaced by an historical sketch of the separate branch of observation, which will prove of considerable interest to an observer, and supplies an easy method of valuable information being acquired. The catalogue in our hands is not complete, and is merely a compilation of some sectional lists; the paging shows how much is missing. In the sections for barometer and thermometer the lists do not give the self-recording instruments, although in rainfall and wind the registration instruments are fully dealt with. The section for deep-sea thermometers well illustrates the advantage secured by the long association of the optician with special scientific instruments; these thermometers have been carefully watched and improved by the maker for about half a century. Sunshine instruments of two recognised forms are well described and compared: the "Campbell-Stokes" recorder burns a trace on a time-divided card by the impinging of the sun's rays focussed through a sphere of glass; this system is generally adopted by the Meteorological Office. The other form is the "Jordan" recorder, in which a photograph of the rays of the sun is obtained upon a specially sensitised chart. The catalogue will be forwarded by Messrs. Negretti and Zambra to anyone who may be interested.

According to an article by M. Jacques Boyer in *La Nature* for September 4, the aerotechnical institute of the Military Academy at Saint-Cyr has installed a pneumatic tank for experiments on the effects of reduced air-pressure and temperature on the physical powers of aviators. The tank in use up to the present time is 2 metres in diameter and nearly 4 metres long. It is of steel 5 mm. thick, and is insulated thermally by an outside layer of cork 10 cm. thick. Four glazed portholes are provided, through which the officer in charge can observe the aviator under test inside. Air-pumps and an air-refrigeration plant are provided, so that the pressure and temperature of the air in the tank can be varied at will. Oxygen tubes are also available, and the interior and exterior of the tank are in communication by telephone. By the help of this tank Dr. Garsaux has been able to study to what altitude aviators could ascend without losing their skill or injuring themselves, and at what stage of the ascent oxygen should be supplied. These altitudes differ according to the temperament of the aviator, but 6000 metres appears to be the limit for even the best men, and oxygen becomes necessary at 3500 or 4000 metres. Further observations are to be made with a larger tank.

A useful account of the "synthetic" drugs is given by Prof. J. T. Hewitt in a series of Cantor lectures recently published (Journal of the Royal Society of Arts, August 13 and 20). Strictly, the phrase "synthetic drugs," implying as it does that the substances in question are produced artificially and find a use in medicine, would include many fairly simple compounds, such as chloroform; but in practice it is restricted to more or less complex carbon compounds which are either prepared by truly synthetic methods (*e.g.* veronal, phenacetin), or obtained by modifying the structure of naturally occurring compounds through chemical treatment. Thus morphine is converted into codeine (methyl morphine) or into heroin (diacetyl morphine) by appropriate chemical reactions. The lecturer classifies the various products according to their chemical relationships as derivatives of hydrocarbons, alcohols, ketones, and so on, thus obtaining a systematic survey of the various groups. The descriptions of the drugs are supplemented by outlines of the methods of manufacture, and in many instances include notes on the history and literature.

A simple form of thermo-electric pyrometer, mainly intended for use with electric resistance furnaces, has been placed on the market by the Automatic and Electric Furnaces, Ltd. The thermo-couple is composed of wires of nickel and nickel-chrome alloy, these metals being chosen owing to their resistance to oxidation at temperatures not exceeding 1000° C. The E.M.F. developed by this couple is only about one-half that furnished by a junction of iron and constantan, but is still sufficiently high to enable a pivoted indicator to be used. In order to avoid cold-junction errors, the leads to the indicator consist of the same materials as those of the thermo-couple—a procedure now followed generally in the case of base-metal junctions. In a leaflet issued by the firm an account is given of experiments performed with the view of determining the lag caused by the use of thick wires, and also that due to the use of a protecting sheath. The results show that notable errors may arise by assuming that a sheathed junction closely follows the changing temperature of a furnace, particularly when thick wires are used; and it is concluded that the wires should be as thin as possible—consistent with sufficient strength—and, when permissible, should be used uncovered. Two types of instrument are made: one with the junction unprotected, and intended for use in a clean atmosphere; and the other provided with a silica sheath for use in salt-baths, wires of No. 20 gauge being used in each. Both forms should prove useful for the class of work for which they are intended.

Arranged by the Institution of Petroleum Technologists, an interesting lecture on petroleum refining was given on September 8 by Dr. A. E. Dunstan. Crude petroleum is a very complex mixture of substances, which are most conveniently utilised if separated into groups (petrol, "white spirit," kerosene, fuel-oil, and so on) according to their volatility. One object of refining is to effect this separation; a second is to remove impurities, colour, and odour from the products. Probably in the future physico-chemical methods rather than purely chemical treatment will be relied upon for the removal of impurities. Sulphur compounds in particular are mentioned as substances which are adsorbed by passing oil distillates through a column of bauxite or fuller's earth, or, alternatively, by passing the vapour of the oil over heated bauxite. A fact not very generally known is that "toluol" (toluene), so urgently wanted in the war period, occurs naturally in certain varieties of crude petroleum, and "innumerable tons" of it were, indeed, obtained from this source. It is much purer than the toluol extracted from coal-tar, and the lecturer predicts a "future" for the aromatic hydrocarbons yielded by petroleum. Toluol can also be manufactured by "cracking" petroleum—that is, breaking down the more complex molecules into simpler ones by means of heat. This operation, which in its modern forms the lecturer dates back to a patent issued in 1890 to the late Sir Boverton Redwood and Sir James Dewar, is considered to be the most promising way of increasing supplies of petrol from petroleum sources.

AMONG points of interest in the report (Cmd. 881) of the Government Chemist on the work of his department during the past financial year we note that radium was extracted from many thousands of luminous dials, compass-cards, gun-sights, and similar materials made for use during the war. The extraction was complicated by the overwhelming proportion of paint with which the radium was mixed, but practically all was recovered and converted into a form suitable for further use at a comparatively small cost. For the Board of Trade 532 samples of the potash material supplied by Germany to this country were analysed. The samples taken were divided into three portions; one was analysed in Germany, another here, and the third retained in a neutral country for reference in case of dispute. The report, however, does not indicate whether any dispute actually arose. Incidentally, in connection with other samples, a method was worked out for differentiating between sodium chloride and potassium chloride in solid caustic potash. A good deal of work was done on the determination of the nature and proportion of the possible toxic constituents which might be present in water receiving drainage from tarred roads. In the course of this work new and delicate methods for detecting some of the substances were devised. Carbolic acid, for instance, can now be detected and estimated when present in even smaller proportion than one part in a million parts of water. The total number of samples, 368,898, dealt with during the year showed an increase of nearly 80,000 compared with the previous year. The principal increases were due to imported goods, such as wine, sugar, tea, and cocoa; they are indicative of the revival of trade after the return to peace conditions.

WE have just received the Lincolnshire Naturalists' Union Transactions for 1919. The first portion of the volume is devoted to the annual reports of the sectional officers, recording, in most cases, the work which has been done during the past year in their own departments. The report from the botany section is somewhat different; it consists of notes selected from observations on seed-dispersal which have been made during the past fifty years by the sectional president and his colleagues. The methods adopted by birds for the transportation of seeds over long distances are mentioned, and the remainder of the report is given over to a list of the agents and methods by which the seeds of the commoner trees are dispersed. A complete list of the author's observations, which he promises to publish in a future volume, "The Flora of Lincolnshire," will be welcomed by ecologists. The volume also includes lists of marine shells of the Lincolnshire coast by Mr. A. Smith, and of non-marine mollusca of the county, contributed by Mr. J. W. Musham from data obtained from the manuscripts of the late Mr. W. J. Roebuck.

Our Astronomical Column.

ANOTHER QUICKLY MOVING DWARF STAR.—Mr. Innes's zeal in examining pairs of plates with the blink micrometer has been rewarded by the discovery of another very interesting dwarf star with a large proper motion and parallax. The former was detected from plates taken at Sydney, the latter from a series of fourteen plates taken at Johannesburg with the Franklin-Adams lens. The star is of the 12th magnitude; its position for 1920 is R.A. 11h. 12m. 52·39s., S. decl. 57° 8′ 13·1″; the proper motion in R.A. is −2·506″, in decl. +0·973″, total 2·688″ in P.A. 291·2°. The parallax from R.A. measures was found to be 0·350″, that from declination measures 0·324″.

The proper motion of α Centauri is 3·68″ in P.A. 281·4°. That of the present star is sufficiently near this to suggest that it may belong to the same system. Mr. Innes notes that if this were the case its parallax would be about 0·5″. It is not stated whether he took the radial velocity of α Centauri into account; in any case, the observed parallax is sufficiently near to render the assumption of connection tenable.

PROF. BARNARD'S OBSERVATIONS OF NOVA PERSEI.—Prof. Barnard puts the Yerkes refractor to good use in continuing to observe novæ long after they have become too faint for ordinary observers. The Monthly Notices, R.A.S., for June contains his observations of Nova Persei, 1901. Its light is still subject to fluctuations; thus it rose from 13·7 to 12·6 between 1919 November 15 and 18, declining again to 13·7 in the three following days. The mean value in 1920 is 13·48, and the progressive decline appears to have ceased. Unlike some other novæ, its aspect does not now differ from that of an ordinary star, and Prof. Barnard considers that it has returned very closely to its condition before the outburst. Micrometer measures of position appear to show a slight proper motion of the nova relatively to faint adjacent stars, the centennial displacement being 1·08″ in the direction of diminishing R.A. and 2·20″ S.

It is noted that the period required to decline to the pre-nova condition varies in different stars between eight and fifteen years, which is surprisingly short, considering the tremendous character of the outburst.

THE BERGEDORF OBSERVATORY, HAMBURG.—Vol. ii, Nos. 3–5, of the Abhandlungen of this observatory, which has just been issued, contains a useful catalogue of the positions, magnitudes, and colour-indices of the stars in the Pleiades (584 in number) down to mag. 14. The magnitudes were determined by observations with two wedge-photometers. Comparison with Hertzsprung's photographic catalogue shows that the visual magnitudes of the fainter stars are brighter in the mean by 0·7. The colour-indices increase rapidly from mags. 3 to 10, remaining fairly constant after this. Comparison is also made between the number of stars in each half-magnitude interval and the number to be expected in an average region of the same area in galactic latitude 23·7°, using the table of Van Rhijn. For stars brighter than mag. 11 the excess is more than threefold; it then gradually declines, reaching zero at mag. 13½. Another essay discusses the planetary observations made from 1909 to 1920. An interesting round dark spot on Jupiter had the abnormally large rotation period of 9h. 58·13m. from 1920, February 17 to March 18; it then split into two portions, one retaining the same rotation period, while the other had the value 9h. 53·5m., from observations between March 27 and April 1. There is also a study of the contour lines of equal luminosity in the Milky Way (north of decl. −25°). The brightest regions are between γ and β Cygni and in Sagittarius.

Physiological Effects of Insufficient Oxygen Supply.*

By J. Barcroft, C.B.E., M.A., F.R.S.

PROMINENT among the pathological conditions which claimed attention during the war was that of insufficient oxygen supply to the tissues, or anoxæmia. The statement has been made that "anoxæmia not only stops the machine, but wrecks the machinery." This phrase is so apposite that I shall commence by an inquiry as to the limits within which it is true.

Anything like complete anoxæmia stops the machine with almost incredible rapidity. Though the breath can be held for a time, it must be borne in mind that the lungs normally contain about half a litre of oxygen, and that this will suffice for the body at rest for upwards of two minutes. But get rid of the residual oxygen from the lungs even to the extent possible by the breathing of nitrogen, and you will find that only with difficulty will you endure half a minute. It seems doubtful whether complete absence of oxygen would not bring the brain to an instantaneous standstill. So convincing are the experimental facts to anyone who has tested them for himself that I will not further labour the power of anoxæmia to stop the machine. I will, however, say a word about the assumption which I have made that the machine in this connection is the brain.

It cannot be stated too clearly that anoxæmia in the last resort must affect every organ of the body directly. Stoppage of the oxygen supply is known to bring the perfused heart to a standstill, to cause a cessation of the flow of urine, to produce muscular fatigue, and at last immobility, but from our present point of view these effects seem to me to be out of the picture because the brain is so much the most sensitive to oxygen want.

To what extent does acute anoxæmia in a healthy subject wreck the machinery as well as stop the machine? By acute anoxæmia I mean complete or almost complete deprivation of oxygen which, in the matter of time, is too short to prove fatal. No doubt many data might be quoted of men who have recovered from drowning, etc. Such data are complicated by the fact that anoxæmia has only been a factor in their condition. These data, therefore, have a value in so far as they show that a very great degree of anoxæmia, if acute and of short duration, may be experienced with but little wreckage to the machine. They have but little value in showing that such wreckage is due to the anoxæmia, because the anoxæmia has not been the sole disturbance.

Cases in which the anoxæmia has been uncomplicated are to be found among those who have been exposed to low atmospheric pressures; for instance, balloonists and aviators. Of these quite a considerable number have suffered from oxygen want to the extent of being unconscious for short intervals of time.

No scientific observer has pushed a general condition of anoxæmia either on himself or on his fellows to the extent of complete unconsciousness. The most severe experiments of this nature are those carried out by Dr. Haldane and his colleagues. One experiment in particular demands attention. Dr. Haldane and Dr. Kellas[1] together spent an hour in a chamber in which the air was reduced to between 320 mm. and 205 mm. It is difficult to say how far they were conscious. Clearly each believed the other to be complete master of his own faculties, but it is evident that Dr. Haldane was not so. I gather that he has no recollection of what took place; that whenever he was consulted about the pressure he gave a stereotyped answer which was the same for all questions; and that even with a little more oxygen present he was sufficiently himself to wish to investigate the colour of his lips in the glass, but insufficiently himself to be conscious that he was looking into the back, and not the front, of the mirror. Dr. Kellas, who could make observations, never discovered Dr. Haldane's mental condition, though boxed up with him for an hour, and went on consulting him automatically. A somewhat similar experiment was performed on the other two observers, with results differing only in degree.

Yet the after-effects are summed up in the following sentence: "All four observers suffered somewhat from headache for several hours after these experiments, but there was no nausea or loss of appetite."

Of real importance in this connection are the results of carbon monoxide poisoning. Of these a large number might be cited. Those interested will find some very instructive cases described in a volume entitled "The Investigation of Mine Air," by the late Sir C. Le Neve Foster and Dr. Haldane.[2] The cases in question were those of a number of officials who went to investigate the mine disaster on Snaefell, in the Isle of Man, in May, 1897. Of the five cases cited all suffered some after-effects, by which I mean that by the time the blood was restored sufficiently to its normal condition for the tissues to get the amount of oxygen which they required, the effects of the asphyxia had not passed off, and to this extent the machine suffered.

To sum up, then, what may be said of the permanent damage caused by acute anoxæmia, it seems to me to be as follows: No degree of anoxæmia which produces a less effect than that of complete unconsciousness leaves anything more than the most transient effects; if the anoxæmia be pushed to the point at which the subject is within a measurable distance of death, the results may take days or weeks to get over, but only in the case of elderly or unsound persons is the machine wrecked beyond repair.[3]

Chronic Anoxaemia.

And now to pass to the consideration of what I may call chronic anoxæmia—that is to say, oxygen want which perhaps is not very great in amount, but is of long duration. The most obvious instances of men subject to chronic anoxæmia are the dwellers at high altitudes. In these the anoxæmia does not wreck the machine. On what I may call the average healthy man anoxæmia begins to tell at about 18,000 ft. At lower altitudes no doubt he will have some passing trouble, but it seems to me from my own experience that this altitude is a very critical one. Yet there are mining camps at such heights in South America at which the work of life is carried on. The machine is kept going by a process of compensation, in part carried out by a modification in the chemical properties of the blood, in which both the carbonic acid and the alkali diminish. The result, according to my interpretation of my own observations on the Peak of

* From the opening address of the President of Section I (Physiology) delivered at the Cardiff meeting of the British Association on August 24.

[1] Haldane, Kellas, and Kennaway. *Journal of Physiology*, vol. liii.

[2] Foster and Haldane. "The Investigation of Mine Air." (Griffin and Co., 1905.)

[3] Since the address was written Dr. Haldane has told me of a number of victims of the same accident who were brought out alive by the search party, but in whose case the machine was wrecked beyond repair. They soon died.

Teneriffe, which appeared to be confirmed by the experiments in a partially vacuous chamber in Copenhagen,[4] was this: The hydrogen-ion concentration of the blood increased slightly, the respiratory centre worked more actively, and the lung became better ventilated with oxygen, with the natural result that the blood became more oxygenated than it would otherwise have been.

The difference which this degree of acclimatisation made was very great. On Monte Rosa in one case 15 mm. of oxygen pressure were gained in the lungs. To put the matter another way, the amount of oxygen in our lungs at the summit was what it would otherwise have been 5000 ft. or 6000 ft. lower down.

The body, then, had fought the anoxæmia and reduced it very much in degree, but at the same time the anoxæmia had in a subtle way done much to stop the powers of the body, for this very acclimatisation is effected at the expense of the ultimate reserve which the body has at its disposal for the purpose of carrying out muscular or other work. The oxygen in the lungs was obtained essentially by breathing at rest as you would normally do when taking some exercise. Clearly, then, if you are partly out of breath before you commence exercise you cannot undertake so much as you otherwise would do. As a friend of mine—who has camped at 23,000 ft., a higher altitude, I believe, than any other man—put it to me: "So great was the effort that we thought twice before we turned over in bed."

One of the interesting problems with regard to chronic anoxæmia is its effect upon the mind. Sir Clement Le Neve Foster's account of himself during CO poisoning shows loss of memory, some degree of intelligence, and a tendency to repeat what is said. The whole train of his symptoms strongly suggests some form of intoxication, and is not dissimilar to that produced by alcoholic excess. Here it may be noted that, so far as isolated nerves are concerned, there is very good evidence that alcohol and want of oxygen produce exactly the same effects, *i.e.* they cause a decrement in the conducting power of the nerve. And herein lies a part of its interest, for pharmacologists of one school, at all events, tell me that the corresponding effects of alcohol are really due to an inhibition of the higher centres of the mind; you can, therefore, conceive of the mental mechanism of self-control being knocked out either because it has not oxygen enough with which to "carry on," or because it is drugged by some poison as a secondary result of the anoxæmia.

To pass now to the results of more chronic anoxæmia, if I were to try to summarise them in a sentence I should say that, just as acute anoxæmia simulates drunkenness, chronic anoxæmia simulates fatigue.

A page in my note-book written at the Alta Vista Hut, at an altitude of 12,000 ft., commences with a scrawl which is crossed out, then "6 Sept.," the word "Sept." is crossed out and "March" is inserted, "March" shares the same fate as "Sept.," and "April," the correct month, is substituted, and so on, more crossings out and corrections. All this you might say with justice is the action of a tired man. The other pages written at lower altitudes do not, however, bear out the idea that I was out of health at the time, and there was no reason for tiredness on that particular day. Another symptom frequently associated with mental fatigue is irritability. Anyone who has experience of high altitudes knows to his cost that life does not run smoothly at 10,000 ft. If the trouble is not with one's own temper, it is with those of one's colleagues; and so it was in many cases of gas poisoning and in the case of aviators. In these subjects the apparent fatigue sometimes passed into a definitely neurasthenic condition. At this point an issue appeared to arise between the partisans of two theories. One camp said that the symptoms were definitely those of anoxæmia, the other that they were due to nerve-strain. As I have indicated later on, it is not clear that these two views are mutually exclusive. It takes two substances to make an oxidation, the oxygen and the oxidised material. If the oxidation does not take place, the cause may lie in the absence of either or of both, in each case with a similar effect. The subject really is not ripe for controversy, but it is amply ripe for research—research in which both the degree of anoxæmia and the symptoms of fatigue are clearly defined.

So much, then, for the injury to the machine wrought by chronic anoxæmia.

Types of Anoxaemia.

Anoxæmia is by derivation want of oxygen in the blood. Suppose you allow your mind to pass to some much more homely substance than oxygen—such, for instance, as milk—and consider the causes which may conspire to deprive your family of milk, three obvious sources of milk deficiency will occur to you at once: (1) There is not enough milk at the dairy; (2) the milk is watered or otherwise adulterated so that the fluid on sale is not really all milk; and (3) the milkman from that particular dairy does not come down your road.

These three sources of milk deficiency are typical of the types of oxygen deficiency.

The first is insufficient oxygen dispensed to the blood by the lungs. An example of this type of anoxæmia is mountain-sickness. The characteristic of it is insufficient *pressure* of oxygen in the blood. In mountain-sickness the insufficiency of pressure in the blood is due to insufficient pressure in the air. But this type of anoxæmia may be due to other causes. In such cases, either caused by obstruction, by shallow respiration, or by the presence of fluid in the alveoli, the blood leaving the affected areas will contain considerable quantities of reduced hæmoglobin. This will mix with blood from unaffected areas which is about 95 per cent. saturated. The oxygen will then be shared round equally among the corpuscles of the mixed blood, and if the resultant is only 85–90 per cent. saturated the pressure of oxygen will only be about half the normal, and, as I said, deficiency of oxygen pressure is the characteristic of this type of anoxæmia.

The second type involves no want of oxygen pressure in the arterial blood; it is comparable to the watered milk. The deficiency is really in the quality of the blood, and not in the quantity of oxygen to which the blood has access. The most obvious example is anæmia, in which the blood contains too low a percentage of hæmoglobin, and because there is too little hæmoglobin to carry the oxygen, too little oxygen is carried. Anæmia is, however, only one example of this type of anoxæmia. The hæmoglobin may be useless for the purpose of oxygen transport; it may be turned in part into methæmoglobin, as in several diseases, *e.g.* among workers in the manufacture of some chemicals, and in some forms of dysentery contracted in tropical climates, or it may be monopolised by carbon monoxide, as in mine-air.

Thirdly, the blood may have access to sufficient oxygen and may contain sufficient functional hæmoglobin, but owing to transport trouble it may not be

[4] Hasselbach and Lindhard, quoted by Bainbridge.

circulated in sufficient quantities to the tissues. The quantity of oxygen which reaches the tissue in unit time is too small. Literally, according to the strict derivation of the word "anoxæmia," the third type should perhaps be excluded from the category of conditions covered by that word, but as the result is oxygen starvation in the tissues it will be convenient to include it.

The obvious types of anoxæmia may therefore be classified in some such scheme as the following:

ANOXÆMIA.

1. *Anoxic Type.*	2. *Anaemic Type.*	3. *Stagnant Type.*
The pressure of oxygen in the blood is too low. The hæmoglobin is not saturated to the normal extent. The blood is dark. Examples: 1. Rare atmospheres. 2. Areas of lung partially unventilated. 3. Fluid or fibrin on surface of cells.	The quantity of functional hæmoglobin is too small. The oxygen pressure is normal. The blood is normal in colour. Examples 1. Too little hæmoglobin. 2. CO hæmoglobin. 3. Methæmoglobin.	The blood is normal, but is supplied to the tissues in insufficient quantities. Examples: 1. Secondary result of histamine shock. 2. Hæmorrhage. 3. Back pressure.

Anoxic anoxæmia is essentially a general as opposed to a local condition. Not only is the pressure of oxygen in the blood too low, but the lowness of the pressure, and not the deficiency in the quantity, is the cause of the symptoms observed.

The workers on Pike's Peak, for instance, emphasised the fact that the increase of red-blood corpuscles during their residence at 14,000 ft. was due to deficient oxygen pressure. No doubt they were right, but the point was rather taken from their argument by their assertion in another part of the paper that the oxygen pressure in their arterial blood was anything up to about 100 mm. of mercury. Let me, therefore, take my own case, in which the alveolar pressures are known to be an index of the oxygen pressures in the arterial blood. I will compare my condition on two occasions, the point being that on these two occasions the quantities of oxygen united with the hæmoglobin were as nearly as may be the same, whilst the pressures were widely different.

As I sit here the hæmoglobin value of my blood is 96–97, which corresponds to an oxygen capacity of 0·178 c.c. of O_2 per c.c. of blood. In the oxygen chamber on the last day of my experiment, to which I refer later,[5] the oxygen capacity of my blood was 0·201 c.c. Assuming the blood to be 95 per cent. saturated now and 84 per cent. saturated then, the actual quantity of oxygen in the blood on the two occasions would be:

Oxygen capacity.	Percentage saturation.	Oxygen content.
0·178	95	0·169
0·201	84	0·169

Here I am in my usual health. In the chamber I vomited; my pulse was 86, it is now 56; my head ached in a most distressing fashion; it was with the utmost difficulty that I could carry out routine gas analyses, and when doing so the only objects which I saw distinctly were those on which my attention was concentrated.

In the anoxic type of anoxæmia there may then be quite a sufficient quantity of oxygen in the blood, but a sufficient quantity does not avail in the face of an insufficient pressure. Indeed, as I shall show presently, the anoxic type of anoxæmia is the most serious. We are, therefore, confronted with something of a paradox in that the most severe type of anoxæmia is one in which there is not necessarily an insufficient quantity of oxygen in the blood at all.

It is interesting and not uninstructive to try to calculate the degree to which the tissues are prejudiced by being subjected to various types of anoxæmia. Let us suppose that we have a piece of tissue—muscle, for instance—which normally is under the following conditions:

(*a*) One cubic centimetre of blood per minute runs through it.

(*b*) The total oxygen capacity of this blood is 0·188 c.c. of oxygen per c.c. of blood.

(*c*) The percentage saturation is 97.

(*d*) The oxygen pressure is 100 mm.

(*e*) The oxygen used is 0·059 c.c.

(*f*) The oxygen pressure in the tissues is half of that in the veins, in this case 19 mm.

My colleague, Mr. F. J. Roughton, has calculated the amount of oxygen which would penetrate this tissue from the blood in each type of anoxæmia, if the oxygen which reached it in the blood was reduced to 66 per cent. of the quantity stated above.

Measurement of Anoxaemia.

In the study of all physical processes there comes a point, and that very early, when it becomes necessary to compare them one with another to establish some sort of numerical standard and have some sort of quantitative measurements. The study of anoxæmia has reached that point. By what scale are we to measure oxygen want?

Let us take the anoxic type first. There are two scales which might be applied to it, both concerning the arterial blood; the one is the oxygen pressure in it, the other is the consequent percentage of the hæmoglobin which is oxyhæmoglobin. The important thing is that there should be as little reduced hæmoglobin as possible. The more reduced hæmoglobin there is present, the less saturated is the blood; or, as the American authors say, the more *un*saturated is the blood. They emphasise the fact that it is the quantity of *reduced* hæmoglobin that is the index of the anoxic condition. They speak not of the percentage saturation, but of the percentage of unsaturation. A blood which would ordinarily be called 85 per cent. saturated they speak of as 15 per cent. unsaturated.

Anoxic anoxæmia, in many cases of lung affection, should be measured by the direct method of arterial puncture introduced by Stadie,[6] for the simple reason that the relation between the alveolar air and the arterial blood is quite unknown. Such, for instance, are cases of many lung lesions of pneumonia in which the lung may be functioning only in parts, of pneumothorax, of pleural effusions, of emphysema, of multiple pulmonary embolism, in phases of which the arterial blood has been found experimentally to be unsaturated. In addition to these definite lung lesions there is another type of case on which great stress has been laid by Haldane, Meakins, and Priestley, namely, cases of shallow respiration.[7] A thorough investigation of the arterial blood is such cases is urgently necessary. Indeed, in all cases in which it is practicable, the method of arterial puncture is desirable. But in the cases of many normal persons—as, for instance, those of airmen at different altitudes—alveolar-air determinations would give a useful index.

The anæmic type of anoxæmia is gauged by the quantity of *oxy*hæmoglobin in the blood. In the case of simple anæmias this is measured by the scale in which the normal man counts as 100, and the hæmoglobin in the anæmic individual is expressed as a percentage of this. This method has been stan-

[5] Barcroft, Cooke, Hartridge, Parsons, and Parsons. *Journal of Physiology*, vol. liii., p. 451, 1920.

[6] Stadie. *Journal of Experimental Medicine*, vol. xxx., p. 215, 1919.

[7] Haldane, Meakins, and Priestley. *Journal of Physiology*, vol. lii. p. 420, 1918–19.

dardised carefully by Haldane, and we now know that the man who shows 100 on the scale has an oxygen capacity of 0·185 c.c. of oxygen for every c.c. of blood. We can, therefore, in cases of carboxyhæmoglobin or methæmoglobin poisoning, express the absolute amount of oxyhæmoglobin pressure either by stating the oxygen capacity and so getting an absolute measurement, or in relative units by dividing one hundred times the oxygen capacity by 0·185, and thus getting a figure on the ordinary hæmoglobin metre scale.

The Mechanism of Anoxaemia.

Perhaps the most difficult phase of the discussion is that of how anoxæmia produces its baneful results. Before you discuss whether a certain effect is due to cause A or cause B, be clear in your own mind that A and B are mutually exclusive.

Let me take an example and suppose

(1) That the energy of muscular contraction in the long run depends in some way on the oxidation of sugar;

(2) That in the absence of an adequate supply of oxygen the reaction $C_6H_{12}O_6+6O_2=6CO_2+6H_2O$ cannot take place in its entirety;

(3) That in such circumstances some lactic acid is formed as well as carbonic acid;

(4) That the hydrogen-ion concentration of the blood rises and the total ventilation increases. On what lines are you to discuss whether the increased ventilation is due to "acidosis," by which is meant in this connection the increased hydrogen-ion concentration of the blood, or to "anoxæmia"? Clearly not on the lines that it must be due to one or other, for in the above instance anoxæmia and acidosis are, to some extent, dependent variables.

I have chosen the above case because measurements have been made throughout which make the various assumptions fairly certain, and tell us pretty clearly in what sort of chain to string up the events, what is cause and what is effect. Clearly it would be ridiculous to start a discussion as to whether the breathlessness was due to "acidosis" or "anoxæmia." Each has its place in the chain of events, but I have heard discussions of whether other phenomena of a more obscure nature were due to oxygen want or to acidosis. Such discussions tend to no useful end.

Nor is this the only problem with regard to oxygen want concerning which my warning is needed. Oxygen want may act immediately in at least two ways:

(1) In virtue of absence of oxygen some oxidation which otherwise might take place does not do so, and therefore something which might otherwise happen may not happen. For instance, it may be conceived that the respiratory centre can go through the rhythmic changes of its activity only as the result of the oxidation of its own substance.

(2) A deficient supply of oxygen may produce, not the negation of a chemical action, but an altered chemical action which in its turn produces toxic products that have a secondary effect on such an organism as the respiratory centre.

Now these effects are not mutually exclusive. In the same category are many arguments about whether accumulations of carbonic acid act specifically as such or merely produce an effect in virtue of their effect on the hydrogen-ion concentration. Here again the two points of view are not, strictly speaking, alternatives, and, in some cases at all events, both actions seem to go on at the same time.

It will be evident that in any balanced action in which CO_2 is produced its accumulation will tend to retard the reaction; but, on the other hand, the same accumulation may very likely raise the hydrogen-ion concentration, and in that way produce an effect.

It is rather fashionable at present to say that "the whole question of acidosis and anoxæmia is in a hopeless muddle." To this I answer that if it is in a muddle, I believe the reason to be largely because schools of thought have rallied round words and have taken sides under the impression that they have no common ground. The "muddle," in so far as it exists, is not, I think, by any means hopeless; but I grant freely enough that we are rather at the commencement than at the end of the subject; that much thought and much research must be given, first, in getting accurate data, and, secondly, on relating cause and effect, before the whole subject will seem simple. No effort should be spared to replace indirect by direct measurements. My own inference with regard to changes of the reaction of the blood, based on interpretations of the dissociation curve, should be checked by actual hydrogen-ion measurements, as has been done by Hasselbach and is being done by Donegan and Parsons.[8] Meakins also is, I think, doing great work by actually testing the assumptions made by Haldane, Priestley, and himself as regards the oxygen in arterial blood.

The Compensations for Anoxaemia.

For the anoxic type of anoxæmia two forms of compensation at once suggest themselves. The one is increased hæmoglobin in the blood; the other is increased blood-flow through the tissues. Let us, along the lines of the calculations already made, endeavour to ascertain how far these two types of compensation will really help. To go back to the extreme anoxic case already cited, in which the hæmoglobin was 66 per cent. saturated, let us, first, see what can be accomplished by an increase of the hæmoglobin value of the blood. Such an increase takes place, of course, at high altitudes. Let us suppose that the increase is on the same grand scale as the anoxæmia, and that it is sufficient to restore the actual quantity of oxygen in 1 c.c. of blood to the normal. This, of course, means a rise in the hæmoglobin value of the blood from 100 to 150 on the Gowers scale. Yet even so great an increase in the hæmoglobin will increase the oxygen taken up in the capillary from each c.c. of blood only from 0·031 to 0·036 c.c., and will, therefore, leave it far short of the 0·06 c.c. which every cubic centimetre of normal blood was giving to the tissue. So much, then, for increased hæmoglobin. It gives a little, but only a little, respite. Let us turn, therefore, to increased blood-flow.

In the stagnant type of anoxæmia the principal change which is seen to take place is an increase in the quantity of hæmoglobin per cubic millimetre of blood.

This increase is secondary to a loss of water in the tissues, the result in some cases, as appears from the work of Dale, Richards, and Laidlaw,[9] of a formation of histamine in their cells. Whether this increase of hæmoglobin is to be regarded as merely an accidental occurrence or as a compensation is difficult to decide at present. Roughton's calculations rather surprised us by indicating that increased hæmoglobin acted less efficiently as a compensatory mechanism than we had expected. This conclusion may have been due to the inaccuracy of our assumptions. I must therefore remind you that much experimental evidence is required before the assump-

8 Donegan and Parsons. *Journal of Physiology*, vol. lii., p. 315, 1919.
9 Dale and Richards. *Journal of Physiology*, vol. lii., p. 110, 1919. Dale and Laidlaw. *Ibid.*, p. 355.

tions which are made above are anything but assumptions. But, so far as the evidence available at the present time can teach any lesson, that lesson is this: The only way of dealing satisfactorily with the anoxic type of anoxæmia is to abolish it by in some way supplying the blood with oxygen at a pressure sufficient to saturate it to the normal level.

It has been maintained strenuously by the Oxford school of physiologists that Nature actually did this; that when the partial pressure in the air-cells of the lung was low, the cellular covering of that organ could clutch at the oxygen and force it into the blood at an unnatural pressure, creating a sort of forced draught. This theory, as a theory, has much to recommend it. I am sorry to say, however, that I cannot agree with it on the present evidence. I will only make a passing allusion to the experiment which I performed in order to test the theory, living for six days in a glass respiration-chamber in which the partial pressure of oxygen was gradually reduced until it was at its lowest—about 45 mm. Such a pressure, if the lung was incapable of creating what I have termed a forced draught, would mean an oxygen pressure of 38–40 mm. of mercury in the blood, a change sufficient to make the arterial blood quite dark in colour, whereas, did any considerable forced draught exist, the blood in the arteries would be quite bright in colour. Could we but see the blood in the arteries, its appearance alone would almost give the answer as to whether or no oxygen was forced, or, in technical language, secreted, through the lung-wall. And, of course, we could see the blood in the arteries by the simple process of cutting one of them open and shedding a little into a closed glass tube. To the surgeon this is not a difficult matter, and it was, of course, done. The event showed that the blood was dark, and the most careful analyses failed to discover any evidence that the body can force oxygen into the blood in order to compensate for a deficiency of that gas in the air.

Yet the body is not quite powerless. It can, by breathing more deeply, by increasing the ventilation of the lungs, bring the pressure of oxygen in the air-cells closer to that in the atmosphere breathed than would otherwise be the case. I said just now that the oxygen in my lungs dropped to a minimal pressure of 48 mm.; but it did not remain at that level. When I bestirred myself a little it rose, as the result of increased ventilation of the lung, to 56 mm., and at one time, when I was breathing through valves, it reached 68 mm. Nature will do something, but what Nature does not do should be done by artifice. Exploration of the condition of the arterial blood is only in its infancy, yet many cases have been recorded in which in illness the arterial blood has lacked oxygen as much as, or more than, my own did in the respiration-chamber when I was lying on the last day, with occasional vomiting, racked with headache, and at times able to see clearly only as an effort of concentration. A sick man, if his blood is as anoxic as mine was, cannot be expected to fare better as the result, and so he may be expected to have all my troubles in addition to the graver ones which are, perhaps, attributable to some toxic cause. Can he be spared the anoxæmia? The result of our calculations so far points to the fact that the efficient way of combating the anoxic condition is to give oxygen. During the war it was given with success in the field in cases of gas poisoning, and also special wards were formed on a small scale in this country in which the level of oxygen in the atmosphere was kept up to about 40 per cent., with great benefit to a large percentage of the cases. The practice then inaugurated is being tested at Guy's Hospital by Dr. Hunt, who administered the treatment during the war.

Nor are the advantages of oxygen respiration confined to pathological cases. One of the most direct victims of anoxic anoxæmia is the airman who flies at great heights. Everything in this paper tends to show that to counteract the loss of oxygen which he sustains at high altitudes there is but one policy, namely, to provide him with an oxygen equipment which is at once as light and as efficient as possible—a consummation for which Dr. Haldane has striven unremittingly. And here I come to the personal note on which I should like to conclude. In the pages which I have read views have been expressed which differ from those which he holds in matters of detail—perhaps in matters of important detail. But Dr. Haldane's teaching transcends mere detail. He has always taught that the physiology of to-day is the medicine of to-morrow. The more gladly, therefore, do I take this opportunity of saying how much I owe, and how much I think medicine owes and will owe, to the inspiration of Dr. Haldane's teaching.

The University Problem in London.

A REUNION of the Old Students' Association of the Royal College of Science was held on Tuesday evening, September 14, at the Imperial College Union, South Kensington. The president (Sir Richard Gregory) was in the chair, and the principal feature was an address by Prof. H. E. Armstrong entitled "Pre-Kensington History of the Royal College of Science and the University Problem in London." The address was devoted largely to an autobiographical sketch of Prof. Armstrong's early experiences at the Royal College of Science, dating back to the summer term of 1865, when he became a student of its forerunner, the Royal College of Chemistry, then situate in Oxford Street. Prof. Armstrong's reminiscences of Hofmann, McLeod, Tyndall, Huxley, Frankland, and others were all delightful to listen to, but especially of the first-named did he evidently cherish an affectionate memory. A discussion followed, in which the chairman, Dr. M. O. Forster, Prof. Whitehead, Prof. Morgan, Prof. E. W. Skeats, Dr. G. T. Moody, and Mr. S. W. Hunt took part. Some remarks of the lecturer referring to examinations seemed to be regarded as a polemic against this feature of university life, and called forth a certain amount of timid apology and some vigorous defence. Prof. Armstrong, briefly replying, explained that he did not object to examinations, but to the London system; what he was anxious to see was a series of institutions established in London which would make education effective. It was for each one to consider what was the best system, but so long as each school attempted to do everything there could not be success. The part of the address referring to this subject is subjoined.

I have now fifty years' direct experience of the London University system. Throughout this period the talk has ever been of examinations, never of learning—London has been without educational ideals. Under the system methods of teaching have been hopelessly stereotyped; the teachers have neither been free to teach nor the students to learn. At no time has the character of the training been under discussion; the one concern has been to maintain the "standard" of the examinations—as if there could be a fixed standard when examiners are always being changed and knowledge grows from day to day. No two individuals are mentally comparable. In the degree examinations no allowance has been made for the student's proclivities and choice of profession; for example, whether chemist or physicist, the candidate has been forced to reach the same standard in both chemistry and physics. There may have been a well-meant intention to lay a broad foundation, but there has been no understanding of student-nature.

Philosophers insist that the main office of education is to develop and foster the altruistic spirit—a belief in truth, in goodness, in beauty, in each for its own sake; so we should believe in education primarily for its own sake, as the source of our happiness, not mainly because it brings pecuniary advantage or preferment. From this point of view the present university examination system is one of the most selfish, the most corrupting, ever created; it encourages love of show and advertisement, the spirit of competition and commercialism. Unfortunately, the vested interests which its practice has created are numerous and powerful; the underground influence these will exert in deprecation of change cannot fail to be great. Teachers themselves will be loth to abandon it, for, being paid starvation wages, the pittance they gain from examinations is of consequence.

The Germans alone have grasped the problem of university education. At the degree examination they have only required proof of competent knowledge of the student's chosen subject, together with general knowledge of a couple of cognate subjects which he has been allowed to select from a list. Whatever stones we may throw at German morals, we cannot but admit that their system has given results in practice, whilst ours has not. The time is coming when we shall be forced to allow "self-determination" in higher education as well as in the case of small nations.

Intellectuals are not only a peculiar people, but a mixture of peculiar classes of definitely peculiar people.

We have long ceased to believe in the disciplinary value of this or that subject, and are gradually, but all too slowly, coming to admit that allowance must be made for the extraordinary variation in the ability and intellectual proclivities of individual students. I have given particulars of my own case, but I know of many similar experiences among friends and students whom I have had under constant observation. I know several men who have greatly distinguished themselves as students in subjects which they have thrown entirely to the winds in later life, the study of which has been without the least influence on their mental development. Being acquisitive and conscientious workers, they set themselves to an allotted task and succeeded in it, but the time spent in the study was wasted. Many able students have the advocate's faculty of getting up a case for the time being and as quickly forgetting it when over.

I am satisfied, from long study of the two classes, that the average engineering student and the average chemical or physical student are of two quite different types of mind. The engineering student shies at chemistry and physics, and rarely acquires sympathy with either subject, not because he does not want to learn them, but because their method makes no appeal to his intelligence—the habit of mind of the engineer being constructive, whilst that of the chemist and physicist is analytical and introspective. The engineer usually does work at the request of others; when he realises what is wanted, as a rule he can meet requirements. He is prepared to learn how to use electrical machinery, but he does not want to know much about electricity.

Chemical engineers are being much asked for. We may raise a few by striving to teach engineers to be chemists; a larger proportion, perhaps, by teaching chemists engineering, because many chemists are constructive in their outlook as well as analytical, but in neither case will the hybrid be really competent in both subjects. If we are wise we shall follow the German example and manacle chemist with engineer and attune the two to work in sympathetic vibration. The engineer has been spoilt in this country, and needs to be put in his place. He has far too much assurance, and is believed in just because he does things which make a public show; really, he is not anything like so big as he would have us believe, and is largely dependent on chemists and others who do the work he but plans. All this is by way of emphasising my point that special kinds of university education must be provided to meet the wants of specific classes—that there is no one royal road to effective knowledge. The man who masters a subject he has feeling for does so intuitively—it is in him to understand. When we complain, too often unjustly, of the failure of students in examinations and that they have learnt little or nothing, assuming that it is because they have been inattentive or not applied themselves, we do not realise how difficult it is for most to learn.

To be specific, I am of the opinion that the Imperial College must be autonomous. To be efficient its courses must be most carefully adjusted to suit the special peculiarities of its students, and their ability must be rated by those who can follow and appreciate their work. Only their teachers can do this. As Sir W. H. Bragg and Prof. Starling stated in their striking letter to the *Times* of December 22 last: "The whole development of university education in London is impeded at every step by the subjection of the colleges to an examining body which is incompetent by constitution to deal with academic affairs. Academic freedom is essential to progress." The teachers must always be in advance of the examiners, who necessarily work to a published programme; if they be made subservient, all sense of initiative disappears, and their efforts to improve and advance are stultified and sterilised; moreover, but few students have the desire to work at subjects which do not pay in the examinations, nor can they be blamed in view of the intensity of the struggle for existence. True ideals are only possible under a free system.

But I would not merely free the Imperial College and continue it as it is; I would limit its functions, because I am sure that it does not, and cannot in the future, do all that it now attempts, and apparently desires, to do. It attempts to provide both for physical and biological science, but the requirements of these two branches of knowledge are totally distinct, to be met only by distinct staffs. Devotion to physical science involves and requires a mathematical habit of mind; biological science is definitely non-mathematical in its tendencies; the two habits are very rarely conjoined. Past discussions on heredity afford a striking illustration of this duality. Though a chemist, I happen always to have had marked biological leanings. In studying my colleagues in science, nothing has struck me more than the slight appeal biology makes to those on the physical side. Naturalists there are, not a few; but these, as a rule, are not developed scientific workers. The professed devotee to physical science is rarely a naturalist; even mineralogists are not often found among them. Biochemistry has been to the fore of late years, but the so-called biochemists are mostly just ordinary chemists in disguise, working with materials derived from animal or vegetable substance. The number who have distinct biological feeling is very small—probably to be counted on the hand.

To meet the entirely special requirements of biology, I would constitute University College an Imperial College of Biological Science and Technology. I would interchange the biological staff of the college at South Kensington and that on the physical side of the college in Gower Street. The Rockefeller gift has rendered this change one that is now easier to make and more desirable than it ever was. If effected, it would at least be a great step towards the solution of the pressing problem of preliminary medical education in London.

To deal with the third of the London colleges, King's, its science may well be handed over to the two colleges I have suggested. Let it, then, become a great independent Imperial College of Arts and Economics.

The three colleges should be federated in one Imperial University of London. The objective of the tripartite organisation would be to make education in each of the three departments effective, which it never will be so long as three conflicting colleges exist in which the same subjects are taught without any provision for the mental dissimilarities to which I have insistently referred.

London and the provincial universities suffer from the disability that they afford no opportunity for social training. Cambridge and Oxford necessarily rank before them in this respect, and the attractiveness of the two ancient Universities cannot be countered, as it largely depends on time and tradition. But social training is of the utmost importance, and the attempt must be made to provide it in London.

> The man of men who knowe h men, the Man of men is he!
> His army is the human race and every foe must flee.

If the Arts College were established on a country site, such as that at Kenwood, space might be found for attractive residential quarters as well as playing fields, and on these latter students from the three colleges might well unite their forces; but it is clear that hostels will be required both at Kensington and in Gower Street. If these had gymnasia and debating halls, students would be much brought together. But even if such provision be made, Cambridge and Oxford, on account of their social advantages, will always tend to attract the intelligence of the nation, and the teaching centres in London and the provinces will suffer accordingly. The only way of competing open to the latter is that each should become so prominent in some special subject that, of necessity, those who wish to be proficient in the subject will be attracted.

Each of the three colleges would award its own degrees. Sir Philip Magnus, who is a conservative advocate of the present system, would have the colleges grant a diploma, leaving the degree to be awarded by the University. In a letter to the *Times* of June 11 last he remarks: "In the interests of university education it is surely wiser to maintain the distinction between a college diploma and a university degree. They do not, and should not, connote the same qualifications, and for that reason, if for no other, they should remain distinct."

As a matter of fact, in London the diploma has connoted the same qualification as the degree; the course of training at the Imperial College is the same, whether or no the student take the university degree; at most he is compelled to "cram" some subject or special section of a subject not in the diploma course. Such learning, we know, is almost always forgotten after the examination is over.

The degree-hunger is upon us; students demand degrees, and will have them at any cost. The question is: Shall it be at the cost of their moral outlook and of much wasted time, or in recognition of honest, thorough work? Scientific workers desire to be designated by some distinct title; even the American puts aside his Republican feeling and is pleased to be called "doctor."

Diploma is not an English word; it is suggestive of exhibitions and a framed illuminated certificate rather than of the university. You cannot call a man "Diplomat so and so"—the more so as diplomacy now ranks as a doubtful profession. When Sir Philip Magnus says that diploma and degree do not connote the same qualifications, he has unconsciously in his mind the idea that the University course includes "arts" training, and counts for culture; but the diploma-holder is not required to pass in any literary subject when a candidate for the degree.

Sir Philip Magnus, I know, fears the neglect of literary study in a college such as the Imperial College, though he has nothing to say against the neglect of science in an arts course. Those who live in houses built of the thinnest of glass should not speak too loudly. This view is based on a fallacy, on the assumption that scientific workers in general are weak on the literary side, especially in expressing themselves. They are no weaker than their literary brethren; as a rule, both come to the University with the same literary preparation; neither has been taught the art of writing. The art of reading is acquired during youth; literary foundations should be laid during the school-years, and, if well and truly laid, will be built upon afterwards. The love of books can come only as a free gift, through quiet suggestion and opportunity and leisure to read. The university is the place for special study and self-development—the place where chances sacrificed at school are often recovered; but as the future student of science in an efficient college will be required to record the work he does in accurate and logical terms and to be concise in his statements, he will, in fact, receive definite literary training, maybe in advance of his literary contemporary.

Under a federal scheme such as I have outlined a student would be free to attend courses at a college not his own, and would have credit for such outside attendance. He would be as broad as his heredity would permit.

My proposals may seem to be revolutionary, but we need a revolution in education to make it effective. Merely to mend and patch the old machine will not help us; new ideals should prevail. We must determine to go forward, putting self in the background and thinking only of national interests. Somewhere a leader must be found: "to see and dare and decide; to be a fixed pillar in the welter of uncertainty." It is our imperative duty to "shut together the clasps of resolve."

> Dreading retreat, dreading advance to make,
> Round we revolve, like to the wounded snake.

At this critical hour there can be no better call to all than that of the single line in the biting, short poem "To England," in a recent issue (August 26) of the *Times*:

> Show what you are, *of high and generous race.*

The Exmoor Earthquake of September 10.

EARLY in the morning of Friday, September 10, three slight earthquakes were felt in North Devon in the district between Morte Bay and Exmoor Forest. The first occurred at about 12.15 a.m., and this was followed about an hour later by two slighter shocks separated by an interval of ten minutes. Though it is reported that part of a chimney was dislodged at East Down, and that the light at Bull Point lighthouse was extinguished, it is doubtful if the intensity of the shock at any place exceeded the degree 4 of the Rossi-Forel scale.

The chief interest of the earthquake lies in its connection with a similar, but slightly stronger, shock which occurred on January 23, 1894 (*Geol. Mag.*, vol. iii., 1896, pp. 553–56). This earthquake disturbed an area 30 miles long, extending from Ilfracombe to about 2 miles east of Dulverton, and 16½ miles wide, the whole area containing about 389 square miles. The centre of the inner isoseismal (intensity 4) was half a mile south-west of Simonsbath. From the dimensions and relative positions of the isoseismal lines it was inferred that the earthquake was due to a fault passing close to Simonsbath, running in the direction E. 22° S., and hading to the south—a position which agrees almost exactly with that of the northern boundary fault of the Morte Slates. The length of the fault-displacement was probably about 10 miles.

From the accounts so far received it appears that the disturbed area of the recent earthquake is shifted to the west. It is about 22 miles long, 13½ miles wide, and contains about 230 square miles. The centre lies half a mile north of East Down and a mile south of the northern boundary fault of the Morte Slates—that is, on its downthrow side. The length of the seismic focus was about 8 miles, with its centre 10 miles west of that of the earthquake of 1894. The points of interest are (1) that, as is so often the case in British earthquakes, the epicentre migrated to the west, and (2) that the lengths of the two foci and the distance between their centres were roughly equal to that which separates the epicentres of British twin earthquakes. C. DAVISON.

Aids to Forecasting.[1]

A LONG-FELT want of the weather forecaster has been a methodical classification of weather types associated with the various weather conditions which present themselves. The weather-chart commonly offers a picture familiar enough to the forecaster, but there is much connected with the movement and development which depends upon the bounding conditions. A low-pressure system or depression when appearing off our south-west coasts may have a clear path to the north-eastward, the high-pressure system in its front giving way to its progress. On the other hand, the high-pressure system or anticyclone may be well established and may maintain its ground, thus compelling the advancing disturbance to adapt its track to the situation—a feature of no uncommon occurrence, but one offering considerable difficulty to the work of the forecaster.

Lt.-Col. Gold has made a good attempt to classify the different types of weather which present themselves, and it seems an advance on any previous effort in this direction. The memoir is not hampered by mathematics, and is the outcome of a classification and analysis made by the Meteorological Section, R.E., in France during the late war. It is an effort to supply the forecaster when in doubt with reference to some previous situations of a similar character, so that he may see what developments occurred.

Forecasting is admitted to be a matter of experience which is not always very lengthy. Fifteen types and sub-types have been selected, and are graphically shown in the diagrams. The controlling feature in the type is the distribution of atmospheric pressure, and especially the position of the anticyclone. The Daily Weather Charts for fourteen years, 1905–18, have been analysed according to these types and are classified by months. The results are given in tables, and the forecaster, having drawn his chart, can see to which type it most nearly corresponds, and then look up the dates in the corresponding month on which the type previously occurred. On reference to the Daily Weather Charts for these days he will be able to trace the later developments.

The type-frequency is given in a table for the several months on the totals for fourteen years, which shows clearly the preference of different types for the separate seasons. The essential weather features associated with each type are clearly set out, and relate primarily to the winds and weather of North-East France and Flanders, although applying also to the conditions over the British Isles. C. H.

[1] "Types of Pressure Distribution, with Notes and Tables for the Fourteen Years 1905–18." By E. Gold. Meteorological Office. Geophysical Memoirs, No. 16. (Published by the Air Ministry.) Price 2s. 6d.

American Work in Genetics.

THE increasing intricacy of genetic problems and the volume of contributions from American investigators are notable features of present-day biology. Selection of a few recent papers will indicate the way in which genetic experiment is permeating many fields of biological research.

Dr. F. B. Sumner is continuing his studies of the Californian races of the deer-mouse, *Peromyscus maniculatus*, and in a paper on geographic variation and Mendelian inheritance (*Journ. Exptl. Zool.*, vol. xxx., No. 3) reaches conclusions which, if substantiated by further work, will be of great interest. The subspecies studied are *rubidus*, which occurs near the coast northwards from San Francisco Bay; *Gambeli*, a coast-form south of the bay; and *sonoriensis*, a desert form from the interior of Southern California. Wild mice were trapped from eight stations within these areas, and caged mice are also being extensively bred. Significant racial differences are found in respect to mean length of skull, ear, foot, pelvis, femur, and tail, width of the dorsal tail stripe, colour of pelage, pigmentation of feet, and number of tail vertebræ. Local differences also occur within the range of the same sub-species. Mutations have been described which show Mendelian inheritance, but in hybrids between geographic races it is claimed that the result is a blend, with very little evidence of later segregation.

Among the numerous genetic studies of extra bristles in Drosophila, that of MacDowell has been most extensive. In two of his latest papers (*Journ. Exptl. Zool.*, vol. xxiii., No. 1, and vol. xxx., No. 4) he has further analysed the effects of selection on the number of bristles. After selection for a high number through several generations, reverse selection was found to be impossible, except after crossing with the normal type, which has four bristles. One main factor determines a monohybrid ratio in crosses with normal flies, but there is no dominance in the ordinary sense, and there are additional genetic differences between flies having extra bristles. Studies by Payne indicate the presence of one bristle factor in the sex chromosome and another in the third group, but the exact relation of these to the increase in number of bristles has not been determined. The environment also influences the number of bristles which appear. In MacDowell's experiments forty-nine generations were bred, and it was found that in a uniform environment selection had no effect after the thirteenth generation; statistical methods show that selection failed to shift the modal condition, and no mutations occurred during the experiments.

In a study of the effects of alcohol on white rats, the same author (Proc. Nat. Acad. Sci., vol. iii., p. 577) finds that alcoholised rats showed a considerable falling off in the weight of their offspring, and a still greater loss in fecundity. Twenty-nine pairs of normal rats produced three hundred young in the same time that thirty alcoholised pairs produced one hundred and eight young. He also (Proc. Soc. Exptl. Biol. and Med., vol. xvi., p. 125) finds that the children and grandchildren of parents which had been treated with alcohol for two months before the birth of their young were less apt than the controls in learning to run a maze or to make a multiple choice.

The Leguminosæ are well known to have usually compound leaves, but several genera have unifoliolate varieties, or even species. Blakeslee (*Journal of Heredity*, April, 1919) describes such a form arising as a mutation in the Adzuki bean (*Phaseolus angularis*). His studies of Datura (Blakeslee and Avery, *Journal of Heredity*, March, 1919) have disclosed a number of new forms differing from the type in shape of capsule, foliage, and other characters. They transmit their characters as a complex, chiefly through the female, and in one instance a distinct new species seems to have arisen which breeds true, but appears to be sterile in crosses with the parent species.

R. R. G.

Increase of Population—a Warning.

PROF. E. M. EAST has much that is important in his address as retiring president of the American Society of Naturalists, meeting at Princeton (*Scientific Monthly*, vol. x., 1920, pp. 603–24). At present there are about 1700 million people, with an annual increase of between 14 and 16 millions. The white race is increasing much more rapidly than the yellow or the black. China's 300 million population is practically stationary. With the exception of France, few white peoples are increasing at a less rate than 10 per thousand. It is true that in most of the civilised countries of the world the birth-rate is slowly but steadily decreasing, but the result is not what many would have us believe. Where the birth-rate is low, the death-rate is low, except in France. Prof. East predicts that, owing to the steadily increasing development of preventive medicine, the decrease in the birth-rate will have no great effect on the natural increase in the world for many years to come. If the rate of increase actually existent during the nineteenth century in the United States should continue, within the span of life of the grandchildren of persons now living the States will contain more than a billion inhabitants. "Long before this eventuality the struggle for existence in those portions of the world at present more densely populated will be something beyond the imagination of those of us who have lived in a time of plenty." The law of diminishing returns is even now in operation in a comparatively new country like America, thought to be supplied with inexhaustible riches. Prof. East considers in detail what may be done by improved utilisation of energies, improved agriculture, improved breeding, and so on; but he is not sanguine. To the criticism that he has not allowed for the "immense possibilities in the way of utilising sea food," he responds with vigour. The cloud grows denser when it is noticed that the birth-rate of the foreign population of the United States, coming largely now from eastern and southern Europe, is so much greater than that of the Anglo-Saxon stock (to which, it is claimed, most of the superior types belong) that within a century the latter will be but a fraction of the whole. Prof. East looks forward to severe restriction of immigration; the spread of education; equitable readjustment in many economic customs; rational marriage selection which will tend to an increase of the birth-rate in families of high civic value; and among the rank and file a restriction of births commensurate with the family resources and the mother's strength.

Glass Technology.

WE have received from the Department of Glass Technology, University of Sheffield, a copy of vol. ii. of "Experimental Researches and Reports" published by that department. The papers included have already appeared in the Journal of the Society of Glass Technology. They range over a somewhat wide field of the glass industry, and include papers dealing with bottle-glass and glass-bottle manufacture, chemical glassware, glass for lamp-working purposes, besides accounts of such relevant investigations as the accurate calibration of burette tubes, a simple apparatus for the detection of strain in glass, and the annealing temperatures of lime-soda and magnesia-soda glasses. There are also a paper descriptive of the glass industry of North America and an account of the year's progress in glass research under the auspices of the Glass Research Delegacy. The condition of the glass industry in this country undoubtedly calls for sustained and systematic research, and this contribution of the Department of Glass Technology of the University of Sheffield must be of considerable assistance to what should be a great and national industry. The newly founded Glass Research Association has also an extensive programme of research in the field of what may be called industrial and laboratory glass, and the British Scientific Instrument Research Association is also more particularly concerned with investigations into optical glass. With such a measure of co-operation and co-ordination as the development of the researches shows to be necessary between these various bodies, there is hope that the users of all types of glass in this country may be able to find a home supply equal, if not superior, to the foreign sources to which, before the war, they perforce had to go for much of the glass they needed.

Rate of Evolution.

PROF. E. G. CONKLIN discusses (*Scientific Monthly*, 1920, vol. x., pp. 589–602) the difficult question of the rate of evolution, including under evolution (*a*) diversification of species, (*b*) more perfect adaptation to the conditions of life, and (*c*) increasing differentiation and integration, or, more briefly, progress. If the rate of diversification ("divergent evolution") depends upon the number of mutations that appear, Prof. Conklin argues that it should be proportional, other things being equal, to the rate of reproduction. But this does not seem to be the case. If the rate of improvement in adaptation ("adaptative evolution") depends upon the rate of mutation and the severity of elimination, it also should be proportional to the rate of reproduction; but the finely adapted birds and mammals have a relatively low rate of reproduction. If the rate of "progressive evolution" depends upon the rate of mutation and the severity of selection, it again should be proportional to the rate of reproduction; but the most complex and most highly differentiated of all animals have the lowest rate of reproduction. In face of the difficulty of accounting for the differences in the rate of evolution, Prof. Conklin doubts whether current theories as to the causes of evolution are wholly satisfactory. It may be doubted, however, whether we are able to state the problems of diversity of rate with sufficient precision to allow of their being used as tests of the validity of the ætiological formulæ in the field. It is likely enough that there are factors of organic evolution still to be discovered, but we do not think that Prof. Conklin exhausts the potency of those that are already known. Thus, after writing: "It seems highly probable that the rate of mutation is influenced by environmental conditions, as Plough has shown in the case of the pomace-fly, and it is probable that environment has played a large part in the rate of evolution," he adds: "On the other hand, the evidences against the inheritance of the effects of use and disuse are so strong that one hesitates to invoke their aid." We submit, however, that the *rôle* of a changeful environment in affording mutational stimulus has very little to do with its *rôle* in imprinting modifications. We agree, all the same, with Prof. Conklin that there is no reason for supposing that the formulation of the factors in evolution is approaching exhaustiveness. Ætiology is still a young science.

University and Educational Intelligence.

THE Air Ministry announces that Dr. O. S. Sinnatt, lecturer in mechanical engineering at King's College, University of London, has been appointed professor of aeronautical science at the R.A.F. Cadet College, Cranwell.

WE learn from *Science* for August 27 that the family of the late Sir John Darling, of Adelaide, South Australia, has contributed the sum of 15,000*l.* towards the cost of erecting a new building for the medical school of the University of Adelaide. This building will be designed to accommodate the departments of physiology, biochemistry, and histology, and the medical library. The building will be erected and equipped at a cost of 25,000*l.*

A FULL account of the courses of instruction in the various departments of Bradford Technical College will be found in the calendar which has just been issued. Full-time day courses in technical sciences are provided which extend over three or four years; they lead to the college diploma. Part-time courses, mainly evening work, are also given. The latter are intended to meet the needs of those who are engaged in industry during the greater part of their time. Special facilities are also given to students who may wish to undertake advanced study or research work. The college is well provided with laboratories, among which may be mentioned the engineering and testing shops, a complete plant for the production of textiles, and a power-house which has been arranged for demonstration purposes.

THE calendar of Birkbeck College has been issued, and contains useful information for students intending to take degrees at London University. The courses provided by the college are set out in detail; they consist of day and evening courses in the faculties of arts and science, and evening courses in the faculties of laws and economics. Facilities are also provided for post-graduate and research work. During the autumn and spring terms special courses of lectures on the history of London will be given, and there will also be four lectures, commencing October 11, on "The Thomson Effect" by Mr. H. R. Nettleton for the physics side. Particulars of university and other courses can be obtained from the office of the college or by letter to the secretary.

THE calendar of the London School of Economics and Political Science has been issued, and contains a detailed syllabus of all the courses available for students. Classes are open to those who intend to proceed to degrees in economics and commerce, and also to such as wish to pursue specialised or advanced study on topics on which they may be engaged. All the courses necessary for the degrees of B.Sc.(Econ.) and B.Com. are given at hours which make it possible for both day and evening students to take them. The school provides courses for a number of university diplomas and school certificates; among these are the university diploma for journalism, the academic diploma in sociology and social science and the certificate in social science, the academic diploma in geography, and the commercial and geography certificates granted by the School itself. Facilities are also provided for students desirous of proceeding to the degrees of Master and Doctor of Science, Philosophy, Laws, and Literature.

IN the calendar of the Merchant Venturers' Technical College, Bristol, attention may be directed to some novel features which are mentioned. The first is the Bristol "sandwich" scheme of training for engineers. This course takes five years to complete, about half of which are spent in a works and the other half in the university. A number of engineering firms co-operate with the college for this instruction, and others have expressed their willingness to accept students who have completed the course, in some cases at reduced premiums. Another feature of the college is a two years' course for apprentices. The curriculum extends over two years, and the classes take up one day each week. Students who pass the two examinations given will receive the Engineer Apprentice's Testamur. A series of popular lectures will also be given during the autumn and spring, two of which should be of scientific interest, namely, "Lightning and Thunder," by Prof. J. T. Macgregor-Morris, and "Devices which Won the War," by Mr. J. R. Raphael.

Societies and Academies.

PARIS.

Academy of Sciences, August 23.—M. Henri Deslandres in the chair.—**A. Lacroix**: The existence in Madagascar of a silicate of scandium and yttrium, thortveitite. This mineral, the richest known in scandium, was discovered in 1911 by J. Schetelig in Norway, and since that time has not been found in any other locality. Amongst specimens collected from the pegmatite of Befanamo, Madagascar, was one which agreed in its physical properties with the mineral described by Schetelig. The presence of scandium, ytterbium, and neoytterbium was confirmed by the spectrograph, and there were also indications of zirconium, aluminium, and titanium. In view of the importance of obtaining a sufficient supply of scandium for a more complete study of this element, other minerals from this region have been examined spectroscopically, and scandium has been detected in cymophane, a mineral not hitherto reported as containing this metal.—E. **Bourquelot**: Remarks on the biochemical method of examining hydrolysable glucosides by emulsin, with reference to the note by M. P. Delauney. Historical account of the results obtained since 1901 by the application of this method. Glucosides have been discovered and isolated in fifty-six species of plants.—E. **Cosserat**: Stars the annual proper motion of which exceeds 0·5″. An addition of two stars to the list published on September 1 in the *Comptes rendus*.—I. **Fredholm**: The reduction of a problem of rational mechanics to a linear integral equation.—P. **Humbert**: The function

$$W_{k, \mu_1, \mu_2 \ldots \mu_n}(x_1, x_2, x_3, \ldots x_n).$$

—W. **Swyngedauw**: The supertensions created by the three harmonics of saturation in triphase transformers.—P. **Bary**: Colloidal sulphur.—P. **Delauney**: The extraction of glucosides from two indigenous orchids: the identification of these glucosides with loroglossin. Details of the extraction of the glucosides from *Orchis simia* and *Ophrys aranifera* are given; the melting points, rotatory power, colour reaction with sulphuric acid, and products of hydrolysis proved the identity in each case with loroglossin.—A. **Krempf**: A new planariform Ctenophore, *Coeloplana gonoctena*.—J. **Feytaud**: The destruction of ants by chloropicrin. Chloropicrin has a destructive effect on the wood-mining ant, *Leucotermes lucifugus*, and particulars are given of the best method of applying this substance for the disinfection of houses.—A. **Paillot**: *Coccobacillus insectorum*. Remarks on a recent note on the same subject by MM. Hollande and Vernier.

SYDNEY.

Linnean Society of New South Wales, July 28.—Mr. J. J. Fletcher, president, in the chair.—A. A. **Hamilton**: Notes from the Botanic Gardens, Sydney. Species of Lepidosperma and Prostanthera and varieties of *Grevillea punicea, Hakea saligna,* and *Prostanthera saxicola* are described as new. New locality records are made for several other species.—J. **Mitchell** and W. S. **Dun**: The Atrypidæ of New South Wales, with references to those recorded from other States of Australia. In addition to the three species of Atrypa already known from New South Wales, three species are described as new. Specimens from Molong, Yass, and Bowning, which externally resemble Meristina, but the internal structure of which shows them to belong to the Atrypidæ, are referred to a proposed new genus. The records of Atrypa from Queensland, Victoria, and Western Australia are revised.—Marjorie I. **Collins**: Note on certain variations of the sporocyst in a species of Saprolegnia. In the species of Saprolegnia examined, Leptolegnia, Pythiopsis, and Achlya conditions of the sporocyst occurred rarely, while the Dictyuchus and Aplanes conditions were frequent; the variations occurred in both club-shaped and cylindrical sporocysts, but were not observed arising from resting sporocysts. Composite sporocysts were observed combining the features of Dictyuchus and Aplanes. Evidence is given in favour of the suggestion that the Aplanes condition has arisen from the Dictyuchus by failure of the protoplast to escape from the germ-tube during its early growth.—Prof. W. N. **Benson**, W. S. **Dun**, and W. R. **Browne**: The geology and petrology of the Great Serpentine Belt of New South Wales, part ix. The geology, palæontology, and petrography of the Currabubula district, with notes on adjacent regions. The relationship structurally and stratigraphically between this region and that formerly described by the writer in the Burindi and Horton River districts is indicated. In the Currabubula district the oldest formation is the Burindi mudstone with tuffs, followed by the Middle Carboniferous Kuttung series, largely composed of keratophyre-tuff and conglomerates, but containing two or three horizons of contorted, seasonally banded "varve-rock" of fluvioglacial origin, accompanied by tillite containing striated, and occasionally faceted, erratics. This series is 9500 ft. in thickness, and contains Rhacopteris and other fossil plants. It is followed by the Werrie series of basalt-flows, which are invaded by a very varied series of sills and dykes radiating from Warragundi Mountain, related to which is an extensive series of keratophyric, andesitic, doleritic, and basaltic sills and dykes which invade the Burindi, and especially the Kuttung rocks.

WASHINGTON, D.C.

National Academy of Sciences (Proceedings, vol. vi., No. 2, February).—Messrs. **Harkins** and **Ewing**: An apparent high pressure due to adsorption, the heat of adsorption, and the density of gas-mask charcoals. In addition to the volume of the pores and density of the active charcoal, the effect of the compressibility, viscosity, and surface tension of the liquid are discussed.—H. J. **Spinden**: Central American calendars and the Gregorian day. Rules are set up for turning Mayan and Mexican dates into the Gregorian calendar so that American history is made more exact than that of Egypt, Greece, or Rome.—C. **Barus**: The torsional magnetic energy absorption of an iron conductor.—Y. **Henderson**: The adjustment to the barometer of the hæmatorespiratory functions in man. It appears that the blood-alkali is controlled by the dissolved CO_2, the amount of CO_2 by preliminary ventilation, and the ventilation by the oxygen partial pressure of the air.—A. S. **King**: A study of absorption spectra with the electric furnace. The tube-resistance furnace hitherto used for the study of emission spectra offers interesting possibilities also in the field of absorption spectra.—A. S. **King**: A study of the effect of a magnetic field on electric-furnace spectra. Lines common to furnace and to spark spectra show no difference in number of components nor in separation; the furnace may thus be used to supplement the spark.—D. F. **Jones**: Selective fertilisation in pollen mixtures. Experiments on maize show that there is a definite receptiveness of the plant to its own kind of pollen, and that in proportion as the cross-fertilisation benefits the progeny the less effective are the germ-cells in accomplishing fertilisation. The writer believes that the assumption that heterogeneity in protoplasmic structure is favourable to developmental efficiency is founded on fallacious reasoning and not supported by the facts.—G. A. **Miller**: Groups generated by two operators, S_1, S_2, which satisfy the conditions $S_1^m = S_2^n$, $(S_1S_2)^k = 1$, and $S_1S_2 = S_2S_1$. Results useful in the study of the generalised groups of the regular polyhedra.—W. E. **Castle**: Model of the linkage system of eleven second-chromosome genes of Drosophila. Continuation of the discussion of the spatial *versus* linear arrangement of the genes with the conclusion that in this case the arrangement appears linear.—G. A. **Baitsell**: The development of connective tissue in the amphibian embryo. The origin of connective tissue lies in an intercellular secretion of the embryonic cells which constitutes the ground substance of the connective secretions from the cells. Under various chemical and mechanical factors this substance forms connective tissue-fibres by consolidation of its minute elements.—F. P. **Underhill**, J. A. **Honeij**, and L. J. **Bogert**: Calcium and magnesium metabolism in certain diseases. Clinically, in leprosy there is loss of bone-salts;

experimentally, the leprous organism tends to retain bone-salts, especially calcium. Clinically, in multiple exostosis bone-salts are inferred to be added to the body; experimentally, the organism tries to rid itself of bone-salts, particularly calcium, and in the stabilised stage throws out excessive quantities of magnesium.—C. G. **Abbot**: The larger opportunities for research on the relations of solar and terrestrial radiation. A general research survey communicated by the National Research Council.—S. R. **Detwiler**: The hyperplasia of nerve-centres resulting from excessive peripheral loading. The experiments proving these results consisted in transplanting the right anterior limb rudiment of *Amblystoma punctatum* a given number of body segments posterior to the normal position.

Books Received.

Department of Scientific and Industrial Research. Fuel Research Board. Special Report No. 3: The Coal Fire. By Dr. M. W. Fishenden. Pp. viii+112. (London: H.M. Stationery Office.) 4*s.* net.

Religion and Science. From Galileo to Bergson. By J. C. Hardwick. Pp. ix+148. (London: S.P.C.K.; New York: The Macmillan Co.) 8*s.* net.

Directions for a Practical Course in Chemical Physiology. By Dr. W. Cramer. Fourth edition. Pp. viii+137. (London: Longmans, Green, and Co.) 4*s.* 6*d.* net.

Organic Chemistry for Medical, Intermediate Science, and Pharmaceutical Students. By Dr. A. K. Macbeth. Pp. xi+235. (London: Longmans, Green, and Co.) 6*s.* 6*d.* net.

The Fireman's Handbook and Guide to Fuel Economy. By C. F. Wade. Pp. viii+84. (London: Longmans, Green, and Co.) 2*s.* 6*d.* net.

From Newton to Einstein, Changing Conceptions of the Universe. By Dr. B. Harrow. Pp. 95. (London: Constable and Co., Ltd.) 2*s.* 6*d.*

The Chemical Analysis of Steel-Works' Materials. By F. Ibbotson. Pp. viii+296. (London: Longmans, Green, and Co.) 21*s.* net.

A Second Course in Mathematics for Technical Students. By P. J. Haler and A. H. Stuart. Pp. viii+363. (London: W. B. Clive.) 6*s.*

Privy Council. Medical Research Council. The Science of Ventilation and Open Air Treatment. Part ii. (Special Report Series, No. 52.) Pp. 295. (London: H.M. Stationery Office.) 6*s.* net.

Induction Coil Design. By M. A. Codd. Pp. vi+239+iv plates. (London: E. and F. N. Spon, Ltd.) 21*s.* net.

The Year-Book of the Universities of the Empire, 1918–1920. Edited by W. H. Dawson. Pp. xiv+503. (London: G. Bell and Sons, Ltd.) 15*s.* net.

Icones Plantarum Formosanarum nec non et Contributiones ad Floram Formosanam. By B. Hayata. Vol. ix. Pp. vii+155+vii plates. (Taihoku: Bureau of Forestry.)

Air Ministry. Meteorological Office. British Meteorological and Magnetic Year Book, 1910. Part v., Réseau Mondial, 1910. Monthly and Annual Summaries of Pressure, Temperature, and Precipitation at Land Stations. Pp. xxiv+112. (London: Meteorological Office, Air Ministry.) 15*s.* net.

The Diary of Opal Whiteley. Pp. xxii+311. (London: G. P. Putnam's Sons.) 7*s.* 6*d.* net.

Ludwig Boltzmanns Vorlesungen über die Prinzipe der Mechanik. Dritter Teil. Elastizitätstheorie und Hydromechanik. Edited by Prof. H. Buchholz. Pp. xiii+608–820. (Leipzig: J. A. Barth.) 21.60 marks.

The Diary of a Sportsman Naturalist in India. By E. P. Stebbing. Pp. xvi+298. (London: John Lane.) 21*s.* net.

The Mining Laws of the British Empire and of Foreign Countries. Vol. i., Nigeria. By G. Stone. Pp. xxiii+254. (London: H.M. Stationery Office.) 15*s.* net.

Ordnance Survey Maps: Their Meaning and Use. By Dr. M. I. Newbigin. Second edition. Pp. 128. (Edinburgh: W. and A. K. Johnston, Ltd.; London: Macmillan and Co., Ltd.) 2*s.* net.

The Laws of Mechanics. By S. H. Stelfox. Pp. xi+201. (London: Methuen and Co., Ltd.) 6*s.*

William Sutherland: A Biography. By W. A. Osborne. Pp. 102. (Melbourne: Lothian Book Pub. Co. Pty., Ltd.; London: *British Australasian.*) 7*s.* 6*d.*

Memoirs of the Geological Survey. Special Reports on the Mineral Resources of Great Britain. Vol. xvi., Refractory Materials: Ganister and Silica—Rock—Sand for Open-hearth Steel Furnaces—Dolomite. Petrography and Chemistry. By Dr. W. H. Thomas, A. F. Hallimond, and E. G. Radley. Pp. iv+115+vii plates. (Southampton: Ordnance Survey Office; London: H.M. Stationery Office.) 5*s.* net.

A Critical Revision of the Genus Eucalyptus. By J. H. Maiden. Vol. v., part 1. (Sydney: Botanic Gardens.) 2*s.* 6*d.*

Solubilities of Inorganic and Organic Substances. By Dr. A. Seidell. Second edition. Pp. xxii+845. (London: C. Lockwood and Son; New York: D. van Nostrand Co.) 45*s.* net.

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A "Tour de Force."

THERE are three fundamental subjects in education—the history of our race, the world around us, and the conditions of health, happiness, and effective work. They correspond to Le Play's "famille, lieu, travail"; to the biologist's "Organism, Environment, Function." Fundamental they certainly are, but it is generally admitted that most men know little about any of them and understand less. We are perhaps deplorably slow to learn, but we are also very badly taught. Especially in regard to the history of mankind it is difficult to forgive our teachers, for we spent so long over it (the other fundamentals were for the "modern" side) and we know that we were not unappetised. Yet for bread we got stones. We find the same disappointment among most of our fellows, the disappointment of half-educated men who know their deficiencies. There are well-known ways of making the study of history grip—the use of graphs and charts, the biographical approach, with its calendar of great men, the emotional and dramatic methods so vividly illustrated by Dr. Hayward, and so on; but they seem rarely to be tested in schools or colleges, and widespread ignorance of a supreme subject prevails. We except, of course, those who are by birth historically minded, who learn in spite of bad methods or the absence of any; though even those who know many historical facts seem often like students who are familiar with fossils, but unaware of the æonic pulse and progress of life.

These bitter reflections are prompted, of course, by Mr. Wells's "Outline of History,"[1] which convinces us of sin. For here we find what, in spite of its imperfections, is of the nature of a revelation—a sketch of the continuous movement from the nebula that became the earth to the League of Nations, a suggestion of the sweep and surge of civilisation, not in one corner, but all the world over, an attempt to focus attention on the things that have counted in the past and are living on, around us and in us, to-day. We use such words as "sketch," "suggestion," and "attempt," not in any disparaging way, but because no single man could offer anything else. The book is called "The Outline." There are probably big omissions, unconscious misinterpretations, mistaken accentuations, and so forth, but the point is that Mr. Wells has shown his day and generation the sort of history of the world that every educated man should have as a possession in his mind. It is a fine thing to have achieved what has hitherto been called impossible. We recall two books of many years ago—Haeckel's "Natural History of Creation" and Krause's "Werden und Vergehen"—which traced the cosmic genesis from nebula to consolidated earth, and the organic evolution from Protists to Man, and did this in a vividly picturesque way. They may not have been quite so fine as we thought they were, but, errors and omissions excepted, they were fine books.

Mr. Wells's "Outline" is another such big gift to education. Perhaps it will be a still bigger gift when someone writes another like it from a different point of view. For out of the mouth of two or more witnesses there is some chance of the truth being stated. But, as the author says, the book is an "experimental contribution to a great and urgently necessary educational reformation, which must ultimately restore universal history, revised, corrected, and brought up to date, to its proper place and use as the backbone of a general education. We say 'restore,' because all the great cultures of the world hitherto, Judaism and Christianity in the Bible, Islam in the Koran, have used some sort of cosmogony and world-history as a basis. It may indeed be argued that without such a basis any really binding culture of men is inconceivable. Without it we are a chaos." We would also quote the striking sentence which expresses Mr. Wells's appreciation of what a

1 "The Outline of History: Being a Plain History of Life and Mankind." By H. G. Wells. Revised and corrected edition. Pp. xx+658. (London: Cassell and Co., Ltd., 1920.) Price 21s. net.

living conception of world-history may mean: "A sense of history as the common adventure of all mankind is as necessary for peace within as it is for peace between the nations." Yet we go on fumbling with educational methods, if such they may be called, which we know do not grip.

As is noted in the Introduction, it is usual to say that the time-table of instruction is full up, and that the idea of learning world-history is preposterous.

"If an Englishman, for example, has found the history of England quite enough for his powers of assimilation, then it seems hopeless to expect his sons and daughters to master universal history, if that is to consist of the history of England, *plus* the history of France, *plus* the history of Russia, and so on. To which the only possible answer is that universal history is at once something more and something less than the aggregate of the national histories to which we are accustomed, that it must be approached in a different spirit and dealt with in a different manner. This book seeks to justify that answer. It has been written primarily to show that *history as one whole* is amenable to a more broad and comprehensive handling than is the history of special nations and periods, a broader handling that will bring it within the normal limitations of time and energy set to the reading and education of an ordinary citizen. . . . History is no exception amongst the sciences; as the gaps fill in, the outline simplifies; as the outlook broadens, the clustering multitude of details dissolves into general laws."

We are forced to add that there would be no difficulty about the time for instruction if the methods employed were psychologically sound, if the suggestions of "historical associations" and clear-headed enthusiasts were put into practice. It is certain, for instance, that the purely intellectual presentation usually slips off the child's mind like water off a duck's back, and that it ought to. Moreover, in higher classes what is wanted is not history *plus* history, but a discipline in the way of reading history of such a kind that it will be natural to continue learning. What we so often do not get are centres of crystallisation—a less static metaphor than it used to seem.

There are nine books in "The Outline of History"—The Making of our World; The Making of Man; The Dawn of History; Judea, Greece, and India; The Rise and Collapse of the Roman Empire; Christianity and Islam; The Great Mongol Empires of the Land Ways and the New Empires of the Sea Ways; The Age of the Great Powers; and then a prospect—The Next Stage in History. It was said of Buffon that he took all Nature for his province and was not embarrassed; but Mr. Wells has an even wider reach. It seems almost superhuman—to be so well done; but the author tells us frankly: "There is not a chapter that has not been examined by some more competent person than himself and very carefully revised. He has particularly to thank his friends Sir E. Ray Lankester, Sir H. H. Johnston, Prof. Gilbert Murray, and Mr. Ernest Barker for much counsel." There is a long list of authorities who have helped in various ways to keep the book true to the facts (their footnotes are illuminating); and he has been fortunate in securing in Mr. J. F. Horrabin a skilful illustrator who has put brains into his drawings.

It need scarcely be said that "The Outline" is a *personal* document—materials had to be selected, much had to be left out; prominence is given to some figures, others are in the background; the relative significance of various movements had to be judged, and all this has been obviously influenced by the author's philosophy. The difference here between Mr. Wells and other historians is that he is so clearly aware of the relativity of his work. There is another way, of course, in which the book is personal: it is written in good style—clear, picturesque, and incisive—and it expresses throughout the serious purpose of improving things by understanding them. Another personal characteristic, familiar to readers of Mr. Wells's books, is the courage of his convictions.

The First Book gives in very brief compass an account of the genesis of the earth and the evolution of organisms. There are a few points that puzzle us, such as an indication that the breastbone of Pterodactyls had no keel, but the sketch is masterly. The Second Book deals with the ascent of man, his Primate ancestry, the extinct Neanderthal offshoot, the first true men and their thoughts, the differentiation into races, with their various languages. The Third Book pictures the dawn of history, the primitive Aryan life, the first civilisations, the early traders and travellers, the beginning of writing, the emergence of priests, and the establishment of classes and castes. The treatment is a fine illustration of the art of leaving out what obscures the main issues and of the reward that comes to a man of science who has insisted on seeing things clearly. It is of great educational value to have this vivid and accurate picture of the rock whence we were hewn and the pit whence we were digged.

What dominates the Fourth Book is the idea that by the beginning of the third century B.C. there had already arisen in the Western civilisation of the Old World the great structural ideas (1) of communicable and verifiable knowledge, as contrasted with priest-guarded mysteries; (2) of one universal God of Righteousness, whose temple is the whole world; and (3) of a world polity of which Alexander the Great became the symbol. "The rest of the history of mankind is very largely the history of these three ideas of science, of a universal righteousness, and of a human commonweal." The Fifth Book gives an account of the rise and collapse of the Roman Empire—an account which seems to us to betray bias. It was a very unsound political system. "The clue to all its failure lies in the absence of any free mental activity and any organisation for the increase, development, and application of knowledge." It was "a colossally ignorant and unimaginative Empire." When the smash came "there was one thing that did not perish, but grew, and that was the tradition of the world-empire of Rome and of the supremacy of the Cæsars." The Great War "mowed down no fewer than four Cæsars" who insisted on keeping up the evil tradition. We do not hear much of Roman Law from Mr. Wells, but he frankly confesses that he "contemplates the law and lawyers of to-day with a temperamental lack of appreciation."

The Sixth Book is chiefly concerned with Christianity and its idea of the Kingdom of God, and with Islam with its broad idea of human brotherhood under God. It is admitted that the founder of Islam "had to tack on to his assertion of the supremacy of God an assertion that Muhammad was in especial his prophet, a queer little lapse into proprietorship, a touchingly baseless claim for the copyright of an idea which, as a matter of fact, he had picked up from the Jews and Christians about him." Regarding Christianity, the author quotes with approval a sentence from Dean Inge's "Outspoken Essays": "St. Paul understood what most Christians never realise, namely, that the Gospel of Christ is not *a* religion, but religion itself in its most universal and deepest significance." Thereafter follows a passage which will interest many, in which Mr. Wells declares that there is no antagonism between science and religion. What he says seems to us to suggest rather that there is no antagonism between science and *morals*. "The psychologist can now stand beside the preacher and assure us that there is no reasoned peace of heart, no balance and no safety in the soul, until a man in losing his life has found it, and has schooled and disciplined his interests and will beyond greeds, rivalries, fears, instincts, and narrow affections." And then he goes on to say, all too elliptically: "The history of our race and personal religious experience run so closely parallel as to seem to a modern observer almost the same thing; both tell of a being at first scattered and blind and utterly confused, feeling its way slowly to the serenity and salvation of an ordered and coherent purpose. That in the simplest is the outline of history; whether one have a religious purpose or disavow a religious purpose altogether, the lines of the outline remain the same."

In the Seventh Book the Age of the Land Ways is illustrated by the great empire of Jengis Khan and his successors, very sympathetically sketched ("the blood in our veins was brewed on the steppes as well as on the ploughlands"). Land ways give place to sea ways and Western civilisation has its renascence ("Europe begins to Think for Itself," "Paper Liberated the Human Mind," "the expansion of human horizons," "intimations of a new and profounder social justice"). The Eighth Book is devoted to the Age of the Great Powers.

"Tremendously as these phantoms, the Powers, rule our minds and lives to-day, they are, as this history shows clearly, things only of the last few centuries, a mere hour, an incidental phase, in the vast, deliberate history of our kind. They mark a phase of relapse, a backwater, as the rise of Machiavellian monarchy marks a backwater; they are part of the same eddy of faltering faith, in a process altogether greater and altogether different in general character, the process of the moral and intellectual reunion of mankind. For a time men have relapsed upon these national or imperial gods of theirs; it is but for a time. The idea of the world state, the universal kingdom of righteousness, of which every living soul shall be a citizen, was already in the world two thousand years ago, never more to leave it. Men know that it is present, even when they refuse to recognise it."

Glimpses of this same vision we find throughout the book; it is so dominant in Mr. Wells's mind that he has seen all history in the light of it. Whether it makes for good history we do not know; it has made for a fascinating book which it does one good to read. Its influence will be far-reaching.

To what prospect does his study of universal history lead Mr. Wells? The trend of human evolution points in the direction of internationalism —but beyond. "Our true nationality is mankind." Religion and education, closely interwoven influences, have been the chief synthetic forces throughout the great story of enlarging human co-operations: of the former we may look for a revival, of the latter a re-adjustment informed with science. As a necessary basis for world co-operation, as a preparation for a world league of men, there must be "*a new telling and interpretation, a common interpretation, of history.*" And that this book will further. "There can be little question that the attainment of a federation of all humanity, together with a sufficient measure of social justice, to ensure health, education, and a rough equality of opportunity to most of the children born into the world, would mean such a release and increase of human energy as to open a new phase in human history." Mr. Wells looks forward to "the final achievement of world-wide political and social unity," which will be reached by and based on righteousness as well as science, "perhaps with long interludes of setback and disaster," but "it will mean no resting stage, nor even a breathing stage, before the development of a new struggle and of new and vaster efforts. Men will unify only to intensify the search for knowledge and power and live as ever for new occasions." Almost the ending of what we cannot but regard as a great book is a key sentence: "Life begins perpetually."

The Dioptrics of Huygens.

Œuvres Complètes de Christiaan Huygens. Tome Treizième. Dioptrique 1653; 1666; 1685–1692. Fascicule i., 1653; 1666. Pp. clxvii+432. Fascicule ii., 1685–1692. Pp. 434–905. (La Haye: Martinus Nijhoff, 1916.)

NEARLY ten years have elapsed since we reviewed the twelfth volume of this great work (NATURE, vol. lxxxiv., p. 491), of which vol. xiii., consisting of two parts of altogether nearly 1100 pages, only lately reached us, though dated 1916. It contains everything written by Huygens on geometrical optics, both what was incorporated in the "Dioptrica" published in his "Opuscula Posthuma" in 1703 and 1728, and various extracts from his manuscripts now printed for the first time.

Already in 1652 and 1653 Huygens had written a treatise on refraction and telescopes, divided into three books, and by the present editors called part i. In the next twelve years he occupied himself with the subject from time to time, as appears from his correspondence. In 1665 he resumed more systematically his researches on spherical aberration, and found results which seemed to him so important that he wrote an essay (part ii.) on them. This was soon interrupted by his settling at Paris as a member of the Academy and a pensioner of Louis XIV., but within a year he had a copy made of all he had yet written on the subject, and this is still in existence. In 1668 Huygens tried to verify by experiments his theory of spherical aberration, by which he thought he would be able to compensate the aberration of the object glass by that of the eyepiece; but this led only to disappointment, and he perceived that it was colour-effects which prevented the realisation of his ideas. He next got the idea of forming the object-glass of two lenses, situated close to each other, an idea which was never incorporated in his MS.; and it was probably the uncertainty he felt about the value of his latest results which still made him put off the publication of his work. In 1672 he heard of Newton's discovery of the composition of white light, and after some hesitation he realised its fundamental importance for the problems of dioptrics, so that the results he had himself found had not the value he had supposed them to have, and they were therefore removed from his MS.

In the meantime the undulatory theory of light had arisen in the mind of Huygens, and he proposed to write a larger work dealing with the new theory and its applications, in which his MS. on dioptrics might find a place. But in 1677 he discovered the explanation of double refraction in Iceland spar, which he considered the finest confirmation of his new theory, and beside which all his earlier work on dioptrics appeared to be of secondary importance. He therefore decided to let this work be preceded by a treatise on the undulatory theory of light and its principal applications, without dealing with the theory of lenses and telescopes. This was the origin of the celebrated little book, "Traité de la lumière," which, though not published till 1690, had been practically completed in 1678. Finally, in 1684, Huygens resumed his researches on the magnifying power of telescopes and questions related thereto, and it was probably in the following year that he wrote nearly all that which in the present edition has been put together in part iii., on telescopes. In 1692 he wrote to Leibniz that he seemed to have finished with the subject, though everything was not yet written down. He then numbered the pages of his MS. in the order which he proposed to follow in the final redaction. This pagination was generally followed in the posthumous edition of 1703, but in this way parts written at very different epochs are mixed up together. The present editors therefore preferred to follow the chronological order, so that the gradual development of Huygens's ideas could be clearly seen. A synoptic table at the end of the introduction shows where each section of the two old editions is to be found in the new one, and also what is now printed for the first time.

As already mentioned, the first part is the treatise of 1653 on refraction and telescopes. Of this, Book I. deals with refraction due to plane and spherical surfaces and lenses. Huygens describes various methods of determining the refractive index of liquids or glass, but thinks it unnecessary to attain great accuracy in this, as the value of the index varies slightly for different liquids and different sorts of glass. He then investigates the two principal problems of this book: the determination of the foci of lenses, and of the places where the images of objects in known positions are formed. If this book had been published in 1653, Huygens would have had undoubted priority for most of his results, though he had (without knowing it) been anticipated by Cavalieri as regards foci. But the important propositions on the places of images were quite new. In September, 1669, when Huygens sent to the Royal Society a series of anagrams to secure priority, Barrow's "Lectiones Opticæ" were in the press. In this work there is a determination of the foci of a spherical lens, and of the position of the image of a luminous point situated on the axis of the lens. And when the "Dioptrica" of Huygens was at last published, in 1703, the "Dioptrica Nova" of Molyneux (1692) and a paper by Halley in the Phil. Trans., 1693, had also much diminished the importance of Huygens's discoveries.

Book II. is "On the Apparent Size of Objects seen by Refraction." Among the contents is an elegant theorem of far-reaching applicability. When an object is seen through a number of lenses, and the positions of the eye and the object are interchanged, while the lenses are undisturbed, the apparent size of the object will be unaltered, and the image will have the same position, upright or inverted. A striking application of this was made by Huygens in Book III., where he shows that the magnifying power of a telescope is the ratio of the diameter of the object-glass to the diameter of the pencil of parallel rays emerging from the eye-lens.

Book III. deals with telescopes and contains, among other things, a description of the Huygenian eye-piece.

As described above, part ii. of Huygens's works treats of spherical aberration, and part iii. of telescopes and microscopes, representing the outcome of his lifelong studies and experiments, made in order to improve the theory and construction of refracting telescopes.

These two beautiful volumes reflect as much credit as did the previous ones on both the editors and the printers. The lengthy introduction and the footnotes are most valuable contributions to the history of optics. The numerous figures in the text are facsimile reproductions of Huygens's own rough diagrams.

J. L. E. D.

Analysis of Foods.

Food Inspection and Analysis: For the Use of Public Analysts, Health Officers, Sanitary Chemists, and Food Economists. By Albert E. Leach. Revised and enlarged by Dr. Andrew L. Winton. Fourth edition. Pp. xix + 1090 + xli plates. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) Price 45*s*. net.

IT is now some sixteen years since this work was first issued, and in the interval it has become favourably known in this country to analysts and others concerned with securing the purity of foodstuffs. In its general plan the book remains much as it was when the first edition was reviewed in these columns (NATURE, vol. lxxi., p. 50, November 17, 1904), though naturally there have been many additions and amendments. The author and reviser have brought between two covers some essential information upon almost every subject with which, in the exercise of his profession, the food analyst is likely to be concerned—from the "cutting up" of beef and mutton to the equipment of a laboratory, and from the taking of a photomicrograph to the use of a hydrogen electrode. The more he employs the book, the more the reader will be confirmed in the impression that the literature of the subject has been well searched and judiciously abstracted for him.

No doubt this quality of comprehensiveness largely accounts for the success which the work has achieved. Still, the quality has its inherent defect. So many things are dealt with that, even in this bulky volume of more than a thousand pages, little space is left for discussion of the difficulties which arise either in making the various analyses or in correctly interpreting the results. It is here that the personal judgment and experience of the individual analyst must come in. The book gives him valuable help, but of a generalised kind. It puts up analytical signposts to indicate the high roads for him, but when off the beaten track he must find his own by-ways.

In preparing the present edition Dr. Winton has had expert assistance for the revision of various sections—as, for example, those on dairy products, meat, cereals, spices, oils, sugars, colouring matters, and flavouring extracts. A special chapter upon the determination of acidity (hydrogen-ion concentration) by the electrical method is contributed by Dr. G. L. Wendt; this contains a lucid explanation of the theory and practice of the process, with details of the apparatus employed. Very few errors have been noticed, but in the section on alcoholic beverages there are some slight inaccuracies respecting English proof spirit. This contains 49·28 per cent. of alcohol by weight, and 57·10 by volume, instead of the values given in the text (49·24 and 57·06); whilst the correct factor for calculating proof spirit from volume percentage is 1·7535, not 1·7525 as stated. Analysts in this country should be on their guard against using the table on p. 754 for determining the original specific gravity of beer. This table was superseded several years ago, so far as statutory purposes are concerned, and it is now mainly of historic interest. The last remark applies also in some degree to the methods described for detecting and estimating methyl alcohol.

As a whole, however, the new edition well maintains the reputation of the work. It contains so much trustworthy information that chemists concerned with foodstuffs will find it invaluable.

C. S.

Adventitious Plants of Tweedside.

The Adventive Flora of Tweedside. By Ida M. Hayward and Dr. George Claridge Druce. Pp. xxxii+296. (Arbroath: T. Buncle and Co., 1919.)

THIS is an interesting book. The usual lists and records of alien plants are not particularly inviting to the botanist generally, and there is no doubt a tendency to look with a tolerant eye upon the labour which is devoted by many workers to the botanical treasures of waste grounds and rubbish heaps. But the present book, like its prototype in Southern France, treats the whole subject on a high plane, and brings out many important general conclusions. The record is founded mainly on the careful fieldwork of Miss Ida Hayward continued for several years. The main share of the identification and classification of the plants has fallen to Dr. G. Claridge Druce. Dr. Druce is so well known for his intensive studies on the flora of Great Britain that one need only say that this part of the work is in keeping with his high reputation. Not the least interesting section of the book is the introductory part, where a summary of the origin of this adventive flora is given along with a short history of the development of the town of Galashiels and its woollen industry. There follows a review of the sources from which Galashiels derives the wool it manufactures into tweeds. Some little space is given to the remarkable survival of the seeds after the very drastic treatment they are subjected to when the wool is passed through some of the preliminary processes. The results obtained of the temperature-resisting power of certain seeds are certainly very remarkable.

In these days of printing difficulties one must refer specially to the excellent way in which the book has been printed. The general list has not been spoiled by paring down the text from pressure of space. Quite ample summaries of the orders and of the genera concerned are included in the text. With the limitations now imposed on the publications of scientific matter by the greatly enhanced cost of printing, one looks with a certain amount of envy on the appearance presented by the book under review, which is quite up to prewar standard. The correctness of the records and the proof-reading leave little scope for criticism. On p. 235, Fig. 71 is subscribed "Polygonum" instead of "Polypogon." On p. 122 *Cotula coronopifolia* is mentioned as recorded for the first time in Scotland by Miss Hayward for August, 1908. It was previously recorded in the Trans. Bot. Soc. Edin., vol. xi., 1873, p. 256, by Mr. William Evans, near Aberdour, Fife. But these are minor points.

The authors need have no care for what Dr. Druce terms the "scoffs of some suburban botanists at the inexhaustible rubbish heaps of Tweedside." The book is worthy of its place beside "La Flore Adventice de Montpellier." Those interested in the flora of Great Britain, especially from the point of view of the influence of cultivation and industry upon the native flora, would do well to have this book upon their shelf. It raises much wider issues than the mere record of accidental aliens.

Meteorological Constants.

Smithsonian Meteorological Tables. Fourth, revised, edition. (Smithsonian Miscellaneous Collections, vol. lix., No. 1.) Pp. lxxii+261. (Washington: Smithsonian Institution, 1918.)

THE first edition of the "Smithsonian Meteorological Tables" was issued in 1893. It is now fourteen years since the last edition came out, and the opportunity has been taken in the present edition to make a number of changes, some of which call for brief comment.

The tables dealing with the relative accelerations due to gravity at different latitudes have been recomputed on the basis of the recent work of the U.S. Coast and Geodetic Survey. New water-vapour pressure tables have been recalculated from the latest Reichsanstalt investigations, a modification of Van der Waal's formula being employed for the purpose of interpolation.

These alterations have involved extensive revision of a number of associated barometric tables, together with those dealing with the ventilated hygrometer, the treatment of which is very satisfactory. The most important advance in the matter of the wet- and dry-bulb hygrometer was the discovery (known to Belli so far back as 1830) that it may be made a trustworthy instrument if the wet bulb is exposed to moving instead of to still air. Even then different instruments were found to give different readings to an extent depending on the shape and dimensions of the thermometer bulb and stem.

But all such idiosyncrasies were swept away by the later discovery that if an air-velocity of not less than 3 metres per second is employed, agreement results in the readings afforded by various instruments. In practice the velocity of the air need not be known so long as it is above that which gives sensibly the greatest depression of the wet-bulb thermometer.

Among other new tables are those for converting barometric inches or millimetres of mercury into the millibars which now receive international acceptance.

The various logarithmic and simpler trigonometrical tables which appeared in former editions have now been omitted—a retrograde step, we think, from the point of view of the convenience of the reader.

It may not be known to all readers of NATURE that the Smithsonian tables are not obtainable in the ordinary way by purchase through a bookseller.

Our Bookshelf.

Elements of Radiotelegraphy. By Lieut. Ellery W. Stone, U.S.N.R.F. Pp. vii + 267 + xxxiii plates. (London: Crosby Lockwood and Son, 1920.) Price 16*s.* 6*d.* net.

THIS is a work written with the primary object of forming a manual of instruction for those in the wireless branch of the U.S. Navy, but on account of the clear sketch of the subject it gives, it will probably appeal to a wider circle. The way in which the elementary principles are set forth should be appreciated on both sides of the Atlantic. Details are given of several systems better known in America than here, but French and German methods, as well as some originating from this country, are also dealt with. The book has a breadth of outlook which is refreshing after some works which tend towards making one think that all wireless progress is due to one group of investigators. The author does not favour any one system unduly, although naturally he has to base a certain proportion of his remarks upon the various systems employed in the American Fleet. This includes a good deal of interest regarding the recent developments of the Poulsen arc system, and apparatus up to 1000 kw. is illustrated. We only regret that considerations of space have rather curtailed the treatment of the thermo-ionic valve, or "electron tube," and that wireless telephony, as distinct from telegraphy, receives only a passing reference, for it is well known that the American Navy made early advances in this direction. The treatment throughout is non-mathematical; the range covered embraces elementary principles as well as up-to-date methods, and the illustrations are excellent.

Exercises from Elementary Algebra. By C. Godfrey and A. W. Siddons. Vols. i. and ii., complete. (With Answers). Pp. x + 395 + c. (Cambridge: At the University Press, 1920.) Price 7*s.* 6*d.* net.

THE exercises in this book are identical with those in the first edition of "Elementary Algebra" by the same authors, with the exception that some new revision papers have been inserted. The first fourteen chapters deal with elementary algebra up to quadratic equations, graphs, and the graphical solution of equations of degree higher than the second. Then follow thirteen chapters which take in logarithms, surds, progressions, rate of change and simple differentiation and integration. An appendix of eight chapters on various forms of linear and quadratic equations, on factors, etc., has been added.

Catalysis and its Industrial Applications. By E. Jobling. Second edition. (Text-books of Chemical Research and Engineering.) Pp. viii + 144. (London: J. and A. Churchill, 1920.) Price 7*s.* 6*d.* net.

THE first edition of this useful little book was reviewed in NATURE for February 17, 1916. Since that time, the subject of catalysis has undergone extensive developments, and the present edition aims at bringing the book up to date. Besides necessary alterations, two chapters have been added, one on the synthesis of acetic acid, alcohol, and allied compounds, and the other on enzymes, electro-chemistry, and vulcanisation accelerators. A number of references, both to text-books and to patents, are given at the end of each chapter for the assistance of readers desirous of obtaining fuller details of the processes discussed.

William Smith: His Maps and Memoirs. By T. Sheppard. Pp. iii+75-253+plates. (Hull: A. Brown and Sons, Ltd., 1920.) Price 7s. 6d.

MR. SHEPPARD has spared no pains in making bibliography attractive. He has reproduced by photography original title-pages and maps; he has added portraits, and views of William Smith's homes at Midford and at Harkness—the latter from a good oil-painting. By quoting characteristic passages, including "The Geology of England: Mr. Wm. Smith's Claims," published in 1817, he has given a very interesting and effective picture of the man. The rarity of Smith's original works—only 250 copies seem to have been printed of the four parts of "Strata identified by Organized Fossils"—has rendered Mr. Sheppard's collation of various copies a labour of time as well as of pious erudition. The result is a book that will be welcomed in every scientific library. Smith's sections across various English districts are here given in a reduced form, and we are grateful to the Yorkshire Geological Society for undertaking this liberality of illustration when Mr. Sheppard's memoir first appeared in its Proceedings. As the author points out, Messrs. Cruchley of London, in quite recent years, sold road-maps of English counties reproduced from John Cary's plates (though of course with the addition of railways), and on some at least of these William Smith's geological data still appeared. If the original plates exist, it might be possible to reconstruct for libraries Smith's "Geological Atlas," much as it was issued between 1819 and 1824.

G. A. J. C.

Practical Histology. By Prof. J. N. Langley. Third edition. Pp. viii+320. (Cambridge: W. Heffer and Sons, Ltd., 1920.) Price 10s. 6d. net.

PROF. J. N. LANGLEY'S work is a laboratory manual containing full directions for students undergoing a course of practical histology. Though primarily a book of histological methods, a description is given of the appearances which should be found after the instructions regarding each preparation have been carried out, but the volume does not aim at being a descriptive histology, and contains no illustrations beyond those of apparatus. Provision is made for the instruction of both junior and senior students, the large type in general representing the course of practical histology for elementary students in Cambridge. Histological methods vary somewhat in different schools, but whatever the general procedure may be, this volume is full of useful information, and may be turned to in confidence for assistance in the preparation of any histological specimen.

Prof. Langley, in his preface, comments on the desirability of histology being taught by the physiologist, seeing that minute structure and function are so bound together. The plea is a good one, but the point of view of the pathologist must not be neglected, for the medical student rarely arrives at a full appreciation of the value of histology until he has studied the pathological alterations which occur in the normal tissues.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

The Separation of the Isotopes of Mercury.

WE have been successful in achieving a partial separation of the isotopes of mercury by evaporating mercury at low pressure and condensing the evaporated atoms on a cooled surface. The rate of evaporation of the isotopes being inversely proportional to the square root of their atomic weight, and practically every atom leaving the liquid being condensed on the highly cooled surface, a partial separation of the isotopes of mercury was to be expected.

By using the pyknometer method the following numbers have been obtained in one set of experiments for the density of the condensed, and in another set for that of the residual, mercury, when taking the density of ordinary mercury as unity:

Condensed mercury ...	0·999980
Residual mercury ...	1·000031

The apparatus contained 40 c.c. of mercury. In the first set of experiments about one-seventh of the mercury was evaporated and the density of the condensed part determined; in the second set about three-fourths of the mercury was evaporated and the residual portion examined. After the separation every portion was distilled again several times in the ordinary way and the density measured after each distillation. No difference was found between these measurements, the error of measurement of density being less than one in a million.

J. N. BRÖNSTED.
G. HEVESY.

Physico-Chemical Laboratory of the Polytechnic High School, Copenhagen, September 23.

The British Association.

THE leading article in NATURE of September 16 directs attention to a matter which must have exercised the thought of most men of science. There is certainly a widespread feeling that the British Association might be better occupied than in listening to papers on special subjects, often given before very small groups of people. Speaking of my own section, that of Physiology, it has become more and more difficult to get promises of communications of this kind, and discussions on questions of interest at the time have been arranged. I am inclined to think, however, that the addresses of presidents of sections are useful when they present general aspects of the science which would be inappropriate in papers published in the proceedings of learned societies or in journals and describing original discoveries. The discussions would undoubtedly be of more value if the practice of joint meetings of several sections were more extensively made use of than is the case at present, since it is becoming less and less possible for a worker in any one branch of science to acquaint himself with advances in other branches, although these may have a very material bearing on his own work. There can be no doubt that the more he knows of other sciences the better equipped is the worker in any particular branch. If the Association were able to remove some of the dangers of the excessive specialisation into which modern science seems to be drifting, it would be a function useful to men of science themselves. I am inclined to think that the reading of original papers, and probably also discussions on subjects of interest, to one section only might well be given up.

But, however this may be, I thoroughly agree that the chief function of the British Association is to arouse interest in science amongst the general public. How this is to be done is not an easy problem. One thing that might certainly be done is to adopt the suggestion of the *Electrician*, and arrange that the latest discoveries in science should be described in simple language. It seems to me that this should be done by several individual workers rather than by one lecturer alone, even in the case of a subject of comparatively narrow field. It is not always possible to know where a hearer may find difficulty of apprehension, and different ways of putting things aid in clearness of grasp. In fact, something more in the nature of a public discussion might be more stimulating and instructive. I am somewhat ignorant as to how far the popular lectures as at present given can be considered to be successful. Personally, I find a set lecture of a length approaching an hour somewhat tiresome; but opinions differ as to this. The presentation of a new discovery by more than one person might tend to overcome the difficulty referred to in the article in NATURE, namely, the fact that genius for discovery is not always associated with facility of popular exposition or with an attractive manner of bringing out its importance. At the same time it should not be forgotten that there is a natural interest in hearing an account of a new discovery from the lips of the man who made it, even though he may not be able to make it as clear as may another speaker whose gifts are of a different kind. Men of science themselves are not devoid of this interest or curiosity. If the practice of formal lectures is followed, I feel sure, from remarks that I have heard, that the method adopted at the Royal Institution is the best—I mean the absence of any introduction or votes of thanks. At the end of an hour's lecture the audience is more or less fatigued and apt to be impatient of the kind of remarks usually made.

If the Association were known to be made up of members from all kinds of callings and positions in life, its pronouncements on such national problems as the teaching of science in schools, the relation of science to the public services, and so on, would have a greater influence. It has already done good work in this way, and could do more.

There is another way in which I venture to think the Association might be useful. Sensational, exaggerated, and inaccurate statements with regard to supposed new discoveries appear from time to time in the daily Press. Those unfamiliar with the facts find it difficult or impossible to learn the truth about them, and when the statements are found at a later date to have no basis scientific credit is likely to suffer. Such assertions as the overthrow of Newton, and even of the foundations of science, by Einstein's work, and the wild statements about the transplantation of glands of internal secretion and about Besredka's work on immunity, require authoritative correction. Possibly committees of a more or less permanent character might meet throughout the year, but it is not easy to see how it could best be done.

The mention of committees suggests an appreciative reference to the Special Reports issued from time to time by the Association. These are frequently of great value as showing the wide bearing of facts in one branch of science upon other branches. The reports on "Colloid Chemistry" may illustrate my meaning. These various reports are by no means so widely known as they should be, and this part of the activity of the Association might well be continued.

I feel some doubt as to whether the research committees repay their cost, and whether their work would not be better transferred to the Department of Scientific and Industrial Research or to the Medical Research Council, as the case may be.

This letter contains little, it is to be feared, in the way of suggestion for constructive advance, but I should like to add my testimony in support of the position taken up in the article in NATURE.

W. M. BAYLISS.

University College, London, September 21.

THE leading article in NATURE of September 16 brings out very clearly what many of us feel to be an increasing difficulty at the meetings, not only of the British Association, but also of most other scientific societies. In fact, it is scarcely an exaggeration to say that members sit through the bulk of meetings and listen to the majority of papers out of mere courtesy. Only in rare instances, when the paper read happens to touch the listener's special line of work, can one take an intelligent interest in the proceedings. Even then it is wise to wait until a paper is in print before forming an opinion. Some good-natured person, however, often sacrifices himself and offers a few trite, and usually irrelevant, remarks which pass muster for a discussion. Under these conditions one is tempted to ask oneself what real good is achieved by such meetings and in what way they can help the progress of research. I admit this state of things is far worse in some subjects than in others; in mathematics it exists in an aggravated form. On the other hand, I have rarely attended a meeting of the Royal Astronomical Society without being stimulated and interested. But this defect is found, in varying degrees, at every scientific meeting, and it grows steadily worse as years go by.

Much of the trouble seems to be due to the increasing subdivision of the departments of science and the tendency of each subdivision to create a nomenclature of its own, so that science is being rapidly threatened with the curse which fell upon the builders of the Tower of Babel. Often a mere name, which if explained in terms known to all scientific workers would be at once mastered, proves a decisive stumbling-block. Thus it is not infrequent to hear the engineer complain of the general unintelligibility of the ordinary mathematician or physicist, but he seems entirely unaware that he himself uses what seems to the others an equally unintelligible jargon.

Another contributory cause, to which your leading article alludes, is that the rapid growth of many borderline sciences is now overshadowing the old recognised domains. In much of the new physical chemistry, for instance, both the physicist and the chemist brought up on classical lines feel themselves equally at sea. The thing has grown up unnoticed, as it were; they have had a glimpse here and a glimpse there, but they have no clear understanding of the new foundations or of how their own work is affected by the new developments. Many would like to obtain this understanding, but find that in order to do so they must first read up hundreds of scattered original papers containing 90 per cent. of matter of no interest to them, and they may have neither the time nor the inclination for the task. The fact is that research in such border-line sciences has outstripped the text-book writer; and although text-books are often bad, they nevertheless have a useful, even an essential, function to fulfil.

If such are the difficulties confronting the trained scientific worker, what are we to say of the intelligent amateur in a provincial town, such as the British Association regularly visits? To him, indeed, much must be Greek, even of the presidential addresses; and the papers, many of quite special and trivial interest, which make up the bulk of the business of the sections, can make no appeal whatever. Indeed, the only surprising thing to me is that any such persons attend the meetings at all; it speaks volumes for their keenness and devotion that some do.

But if the British Association is really to take for one of its tasks the bringing of science home, so to speak, to the British public, if it is to give its energies to what the French call "vulgarisation," and if in addition it is to promote co-operation and understanding between workers in different branches, then it must modify not only the procedure at its meetings, but also the character of its printed reports. These are often scrappy and confusing in the extreme. More attention ought to be paid to systematic expositions of recent scientific developments set forth in such a manner that they can be read and understood by everyone with a fair all-round scientific education, and supplemented by exhaustive references for those who wish to go into the subject. Such "Reports on the State of Science" will not be a new departure in the history of the Association. A good recent example of a difficult mathematical subject so treated is to be found in H. Bateman's report "On the History and Present State of the Theory of Integral Equations," printed in the 1910 Report. On the other hand, much of the material now published under the heading "Reports on the State of Science" seems to me far too special, and could with advantage be published elsewhere.

As to the meetings, I agree entirely with the view expressed in the leading article that the function of a section "should not be technical discussion by specialists for specialists, but the enlightenment of an extensive group of workers as to main lines of advances in fields not specifically their own." To obtain this result what is needed is not a succession of papers by individual specialists, but rather one or two stimulating addresses by a carefully selected lecturer who can be trusted to avoid the faults referred to in your article.

At the same time I suggest there should also be social and entirely informal meetings for semi-private discussion. These should be for real, effective comparing of notes by workers on the same lines, each set chatting round its own table; a member, during the course of one meeting, might talk and listen at several tables in succession.

About organisation, the arbitrary division of science into watertight sections is inevitably bound to lead to trouble as subjects grow. (Incidentally, there is much to be said against the present classification.) The main trouble, however, is that with the sections as at present it is nobody's business to arrange joint meetings to deal with border-line subjects. A possible solution would be to have standing joint committees of groups of sections, the sole duty of which should be that of co-ordination. If need be, the same section could appear in more than one group; thus chemistry might take its place both in a physical and in a physiological group.

L. N. G. Filon.

University of London, University College, September 21.

The problem of the best use that we can make of the annual meetings of the British Association is one that presents many difficulties. There is so much to be accomplished and so little time available—less than ever since 1914, though in this respect I understand the former conditions are to be restored next year.

At present the most important functions of the Association are to stimulate and maintain the interest and activities of local workers, and to enable men of science who are engaged on problems which require the co-operation of a number of observers scattered about the country to obtain new recruits. At the same time the meetings give them the opportunity of addressing a wider audience than that afforded by the scientific societies—an audience which includes a large number of university workers who are resident in the provinces during the university terms and a certain proportion of the men and women, all too few in number, who take an intelligent interest in science, though they have not adopted it as a career.

But, as you have indicated, the Association has almost wholly failed to appeal to the man of at least ordinary intelligence and education who has never seriously considered the purpose and achievements of science. This is, I believe, largely the fault of the methods of our schools. If science has been taught at all, the aim has been to drill the pupil in the use of correct technical language and in the exact mathematical expression of natural laws, instead of to implant a living interest in the subject—a far more important matter in the early stages of mental development.

However that may be, the task with which we are now faced is to attract to the meetings those who are at present quite apathetic about all that concerns the progress of science. We already have a few popular lectures on Royal Institution lines, and no doubt it would be desirable to increase their number; but they should be comparatively brief—forty minutes at most—and arrangements should always be made for the discussion of debatable points by competent speakers. Nothing is so calculated to increase the interest and facilitate the understanding of a subject as its presentation from different aspects. Perhaps the greatest successes of recent meetings have been the inter-sectional discussions, which have on one hand aroused popular interest, and on the other done much to develop co-operation between different branches of science.

I am not in agreement with the idea that a meeting of the British Association should not be made an occasion for the announcement of new discoveries or for the description of new developments in research. Provided they are not of too abstruse a character, they are of great value in increasing the prestige of the Association among its members.

If, however, we wish to attract larger audiences of the general public and secure a wider membership, we must do more to advertise the meetings. Something in the nature of a *catalogue raisonné* of the more interesting features should be circulated some weeks beforehand, especially in the neighbourhood to be visited. Short illustrated articles should be contributed to the local papers indicating the topics that are to be considered and the problems that present themselves for solution—sufficient to whet, but not to satiate, the curiosity of the man in the street, so that he may understand that he will not be compelled to listen to dissertations on abstract subjects in unintelligible phraseology, but will have the opportunity of hearing important and interesting questions discussed in a simple, straightforward fashion that any intelligent man will be able to follow.

John W. Evans.

Imperial College, September 22.

I have been greatly interested in the leading article in Nature of September 16 on the position of the British Association. Anyone is interested in an expression of his own views in better language than he can himself command.

While it is the function of the several scientific societies to do their utmost for the advancement of science, each within its own narrow limits, the Royal Society affording common ground for discussion for the *élite* only, the British Association has primarily a double duty to the nation and to the world. On one hand, it should encourage the "cross-fertilisation of the sciences," as no other body can, by bringing together the members of its various Sections so that each may help the others. This co-operation is valuable, not simply on the border-land where the sciences appear to come in contact, but also because it may penetrate the whole area of a science. Perhaps the time is not far distant when we shall cease to speak of "a science," and the unity of *science*, already begun to be recognised in the elementary schools, will be universally acknowledged. It has been stated that when two Sections meet in common the attendance is greater than the sum of the attendances at the separate meetings of the same Sections. This indicates the need, and the direction in which to look for improvement. On the other hand, the Association is mainly responsible for making known to the public the recent advances in science and their bearing on social life—in other words, their possible practical applications. To this end representatives of each Section should be annually appointed for the task of reporting to the next meeting, in terms which will appeal to the man in the street, the progress which has been made in the advancement of science and its applications. It has even been suggested that two sets of reports should be prepared in this way, one as described and the other for experts, and that these reports should form the chief material for the meeting, not much encouragement being offered to original papers suitable for their respective societies. In the preparation of these reports there should be much intercourse between the representatives of the several Sections, and many of them should be the result of joint work. In some cases distinguished investigators should be invited to describe their results in popular language, irrespective of previous publication in the transactions of learned societies. The advancement of science depends not only on the skill and genius of the expert, but also on the appreciation of the people.

September 24. WM. GARNETT.

As one who regularly attends the meetings of the British Association, and in particular those of Section A, may I be allowed to state that I cannot recall in the last twenty years any meeting of the Association when the attendances at Section A were more numerous than at Cardiff. On several occasions it was almost impossible to obtain a seat in the large lecture hall assigned for our meetings unless one came in good time. This was particularly the case when the discussion took place on the constitution of the atom, so admirably exposed by Dr. Aston and by Sir E. Rutherford. A very large audience also assembled to hear Sir Oliver Lodge's controversial note on popular relativity, and the room was full for the discussion on the origin of spectra. And, too, the majority of those who attended, or at least a very large proportion, were not professional physicists, but members of the Association who take an interest in science in general, and who came to hear about the latest advances in physical science. It is for these members that the Association caters, and it would seem that, so far as Section A is concerned, it is fulfilling its functions quite admirably.

This testimony as to the efficiency of the Association may serve as an antidote to some of the jeremiads as to the decadence of the Association which have appeared in the columns of NATURE. The only drawback to the complete success of Section A was that some of the speakers did not seem to realise the very indifferent acoustical properties of the hall in which our meetings were held.

The relatively meagre attendance at the two evening discourses was accounted for by the local strike of tramwaymen. This made it difficult to get to distant parts of the city when the discourses were finished. A. L. CORTIE.

Stonyhurst College Observatory, September 25.

IN your leading article in NATURE of September 16 you have expressed what many of us have long felt: that the British Association is losing its interest for the people of the locality in which it meets. This is mainly on account of the highly technical character of most of the papers, which are suitable only for meetings of the special societies. The Association should not be regarded as a means of publishing new observations unless these are of fundamental importance. Its object is rather to give an opportunity for the local worker to exchange ideas with those who are more favourably placed. Again, the laboratory worker may come in contact with the practical man in many subjects to the benefit of both. Another useful function it may perform is in the discussion of border-land subjects in which more than one Section may be interested, and which do not lie definitely within the limits of any one of the special societies. In these functions, the extension of scientific interest to wider classes of the community and the removal of the barriers between different sets of scientific observers, the Association may meet a crying need of the time. ARTHUR R. CUSHNY.

University of Edinburgh, September 27.

Uses for Aircraft.

WHEN in the year 1912 I gave the first of the James Forrest lectures on aerial flight, I said that the chief uses of aircraft would probably be for the purposes of war or for sport. As a member of the Advisory Committee for Aeronautics I have been in a position to follow the various developments which have been made since that date, but I see no reason to alter my opinion. While the cost of carriage by air is as high as it necessarily must be at present, the commercial use of aircraft on any considerable scale seems impossible. There is no difficulty in carrying goods; the difficulty is to find any class of goods which, for the sake of halving the time of transit, will bear the increased cost of carriage. A certain small amount of postal work, with a few passengers, so long as the novelty is an attraction, or in special cases, seems to be the only opening. If the ton-mile cost could be reduced to as many farthings as it now is shillings, commercial uses on a much enlarged scale would be found.

For sport and private use (*i.e.* for air-yachts) the existing patterns of machines would have to be altered to allow of a greater range of speed and a greater facility in getting off and landing. Both these objects could be attained by the introduction of wings of variable area. It would be a great advantage also, both for storage and in other ways, if the wings could be properly folded (not merely unshipped and turned back) by the pilot from his seat. I have shown in another place how this might be done for monoplanes, and for these the necessary mechanism is simple. For biplanes it would be more difficult to design, but not impossible.

Among the more special uses of aircraft may be mentioned those of map-making and exploration in difficult countries, and of obtaining information regarding winds and other meteorological matters at various altitudes.

For exploring purposes the machine should be amphibian. In New Guinea, for instance, it is only at a few places on the coast that it would be possible to come down and get off on land not previously cleared, but many of the rivers reach far inland, and (judging from photographs) places could be found even near the mountains where there is a water-surface sufficient for the purpose, provided that the machine has great climbing capacity and a wide range of speed.

An expedition which had aeroplanes at command would have the advantage of photographic maps of the whole district it proposed to explore, and could therefore choose the best routes. Supplies also, which would take days to carry by canoes and porters, might be brought from the coast by air in a few hours; and one has only to read the accounts of previous expeditions to realise what a difference it would have made in the results had the geography of the country been known in advance and had there been no fear of scarcity of provisions.

Among the many ways in which aircraft could help in meteorology, not the least useful would be an examination of the trade winds, especially as regards their variations in altitude and their vertical components in different latitudes. At the present time not much more is known about these winds than their velocities and distribution on the earth's surface.

Exploration and meteorology are scarcely, or only indirectly, commercial matters, and comparatively few aircraft would be required for the purposes suggested, but results of great value might be obtained by their use.

A. MALLOCK.

September 21.

Minerals Hitherto Unknown in Derbyshire.

DURING the past three years I have been conducting investigations relating to the mineralogy of Derbyshire, checking and confirming (or contradicting) asserted occurrences, surveying mineral deposits, and also prospecting, with the result that several minerals —chiefly of scientific interest only—hitherto unknown in Derbyshire have been discovered. The work is not quite completed, and I have not yet issued any paper or other publication upon it, but the following observations may be worth putting on record now:

Zaratite, Nickel-ore.—Samples of this mineral, of a pale emerald-green colour, and usually containing a large quantity of hydrozincite, were recently found in old dumps of decomposed dolerite raised during the early working of a local mine driven in search of lead-ore. When following up the search for further nickel, some nickeliferous hydrozincite (or zinciferous zaratite) was found which was of a blue colour instead of the pure green of zaratite. On analysis this was found to contain *cobalt*, which probably existed as *remingtonite*, the accompanying zinc and nickel existing as their hydrous carbonates. The "mineral" is, therefore, probably a mixture of the three mineral species, hydrozincite, zaratite, and remingtonite.

Considerable difficulty attaches to the following up of such finds with the view of ascertaining the quantity available, as many of these mines are of considerable antiquity and dilapidation, having been driven in search of lead-ore when little or nothing was known of the rarer metals.

Nephrite, Jade.—Near the margin of a basalt quarry at Bonsall a somewhat lenticular nodule-shaped lump of white nephrite was found.

Diabantite.—Beautiful specimens of this uncommon member of the chlorite group of complex silicates were found at Mill Close Mine, Darley Dale, having been raised during the early working of the mine. It occurs in the much decomposed dolerite as radiated spherical aggregates (up to 2 cm. diameter) and of a dark green colour. It is usually associated with calcite in amygdaloidal cavities, has a specific gravity of 2·79, a hardness of 2·3, and is strongly pleochroic.

Cimolite.—A hydrous aluminium silicate. A thin bed of this mineral occurs near Hopton. It is quite white, amorphous, and chalk-like.

Allophane.—A hydrous aluminium silicate. Many of the numerous rake-veins in the mountain limestone of the Middle Peak region are rich in forms of limonite, but chiefly the earthy variety—ochre. In one of these veins which is cut in the Coal Hills Quarry, near Wirksworth, allophane is to be found in more than one form. The commonest form is that of a light amorphous powder; it also occurs as an opaque, white encrustation, and as a translucent, sub-crystalline encrustation of the faintest green tinge due to the presence of a minute trace of malachite.

Utahite (?).—The limestone-shale in the vicinity of Wensley contains a quantity of an insoluble basic ferric sulphate as dull, yellowish-brown films in the shale. Its mode of occurrence renders its accurate analysis difficult, but it seems to be a variety of utahite.

Native Sulphur.—"Native sulphur is said to have been found" is recorded by ancient writers, but no confirmation in recent years seems to have been made. A good specimen was recently found near Eyam. It is a greyish-yellow powder, burning readily when ignited.

Manganese-ore.—Manganese is not a new discovery; the indefinite hydrous oxide—wad—has long been known to exist in certain districts in the county. It has also been previously worked, but the present scarcity (recently mentioned in the House of Commons) led to the work of prospecting for a deposit to be mined on as large a scale as possible. This work has been successful, and arrangements are being made, by the company for which the work was undertaken, for the mining of the ore.

C. S. GARNETT.

Riber View, Oak Road, Matlock,
September 16.

Wheat-bulb Disease.

IN view of their economic bearing and of the nearness of the wheat-sowing season, the data given below should be widely known, all the more that in the latest notice I have seen regarding the life-history of the insect pest concerned (*Rev. Applied Entom.*, June, 1920, abstract of papers by R. Kleine in *Zeitschr. f. angew. Entom.*, Berlin, 1915–16) the practical conclusions given appear to be entirely misleading. These conclusions are that "wheat should be preceded by root crops" and "it is apparently useless to attempt to grow wheat or rye on ground which has not been under cultivation for some time." Now it is chiefly among root crops, especially potatoes, and on fallow ground that the insect elects to lay its eggs. This month, for example, in one infected area I find that the number of potential "wheat-bulb" larvæ in a particular potato-field ranges from six to twenty per square foot of surface, while the next field (pasture) has very few, and the neighbouring wheat-field, which was the sufferer last spring, has still fewer. Obviously to sow wheat on infected ground means laying up progressive trouble for the future. The disease has done much damage this year in the East of Scotland and elsewhere, and is evidently spreading, in this locality at any rate. Larvæ obtained from infected wheat were allowed to pupate in the laboratory here, and the flies which hatched out (*Hylemyia coarctata*, *vide* Theobald's "Agricultural Zoology," 1913, p. 242) were kept until they laid their eggs. (Two of them still survive, though the field Hylemyias are all apparently dead.) The distribution of the eggs in nature was then studied (so far as time allowed) by a method permitting accurate enumeration.

JAMES F. GEMMILL.

Natural History Department, University
College, Dundee, September 23.

The Iridescent Colours of Insects.

By H. ONSLOW.

I.—THE COLOURS OF "THIN FILMS."

IT is strange that the cause of the iridescent hues of insects and other animals should to a great extent still remain one of the unexplained problems of optics: theories have been advanced without end, but so far not one that is completely satisfactory. It is very significant that Prof. R. W. Wood, in speaking of certain metallic films the bright colours of which may be due to an exceedingly fine state of division, remarks: "There appears to be a large number of cases in which brilliant colours are shown which cannot be explained by any of the common laws of optics with which we are familiar. As far as I am aware, no very satisfactory explanation has ever been given of the colours of certain feathers and butterflies, and I strongly suspect there is some action of absorbing matter, in a state of very fine division, upon light waves, which is not yet completely understood."

This opinion is given in spite of the fact that no less an authority than Michelson declares that all the colours in question are surface colours; that is to say, they are due to selective metallic reflection, like the coloured surfaces of aniline dyes and metals. Nothing further is required to show how chaotic and contradictory is the present state of knowledge on this subject.

A discussion of the merits of the rival theories would not here be in place.[1] There will not, however, be much danger in venturing to predict that the almost infinite variety of iridescent colours depends upon every possible factor which can produce such colours. Neglecting the metallic films of Prof. Wood, just mentioned, and analogous cases, it is clear that the colours of insects must be caused in one of the following ways:—

(1) Pigmentation.

(2) Interference of light by "thin films" (as in the case of soap-bubbles).

(3) Diffraction of light by "gratings."

(4) Dispersion of light by prisms.

(5) The scattering of light by small particles (as in the blue of the sky).

(6) Selective metallic reflection (as in metals and aniline dyes).

In dealing with iridescent colours, the first possibility may be neglected, though pigments, such as yellow, are often found combined with structural colours, to form green and so forth.

The Interference of Light by "Thin Films."

This is well known to be the cause of the colour of soap-bubbles and oil films, and it certainly seems to offer one of the best explanations of the iridescence of insects. The late Lord Rayleigh has shown how the objections of Michelson may be met by postulating films of a peculiar structure. Also Biédermann has shown that when iridescent scales are placed in a highly refractive fluid, all colours disappear. This could not possibly occur if the colour were due to a substance resembling aniline dyes, for in these circumstances its body-colour would inevitably be seen by transmitted light. If, however, the colour were due to thin films of air separated by layers of chitin, this loss of colour is exactly what would be expected when the air-spaces were filled by a liquid; for the periodic structure would become a continuous medium. Moreover, Mallock has described how, by applying gentle pressure to scales, the colour fades, sometimes tending to return when the pressure is released. Naturally, if there are plates of chitin separated by air-films, such pressure would alter the spacing between the plates, and thus cause the colour to fade.

Since the minute structure of iridescent scales, etc., had never been examined, the present writer

FIG. 1.—*Ornithoptera poseidon* ♂. Body yellow, wings emerald-green and black. (½ natural size.)

has carried out an extensive microscopical investigation in order to discover whether any light could be thrown on the question by this means. The varied types of the different structures found fully justified the expectation that a number of factors were involved, but though the colours of many scales could be accounted for by well-known laws, in other cases no explanation appeared adequate. A few instances will therefore be selected to illustrate the main types of iridescent colours found in insects.

Morpho menelaus.—The brilliant blue-green of this wonderful insect is well known. It is given by two layers of scales—section *1a*, Fig. 2, the pale blue upper layer, which shows the anomaly of appearing blue both by transmitted and by reflected light (NATURE, vol. ciii., p. 84, April, 1919), and section *1b*, Fig. 2, the deep blue lower layer of scales, which bears a very curious periodic structure. This structure, best seen in transverse sections of the scales, is shown in Fig. 2, *1b*. The films of transparent chitin, *a*, here appear as pillars, and between them there are films of air, *af*. Seen in longitudinal section, these pillars become long,

[1] "On a Periodic Structure in Certain Insect Scales, and the Cause of their Iridescent Colours." By H. Onslow. Read before the Royal Society on January 29, 1920.

narrow strips of chitin, a, Fig. 2, $1c$. The chief peculiarity of these films is that they are placed at right angles, and not parallel, to the surface of the scale or wing, as may clearly be seen from the sections. This results in an obvious consequence, which goes far to prove that the plates are the true cause of colour. It has always been said that the colour of iridescent insects changes towards the violet end of the spectrum, like a flat soap film, when the wing is turned from the normal to grazing incidence. This should be true if the colour were produced by films parallel to the wing surface, but if they were at right angles to it, the reverse should be the case; that is to say, the colour should approach the red end of the spectrum as the angle reaches the grazing incidence.

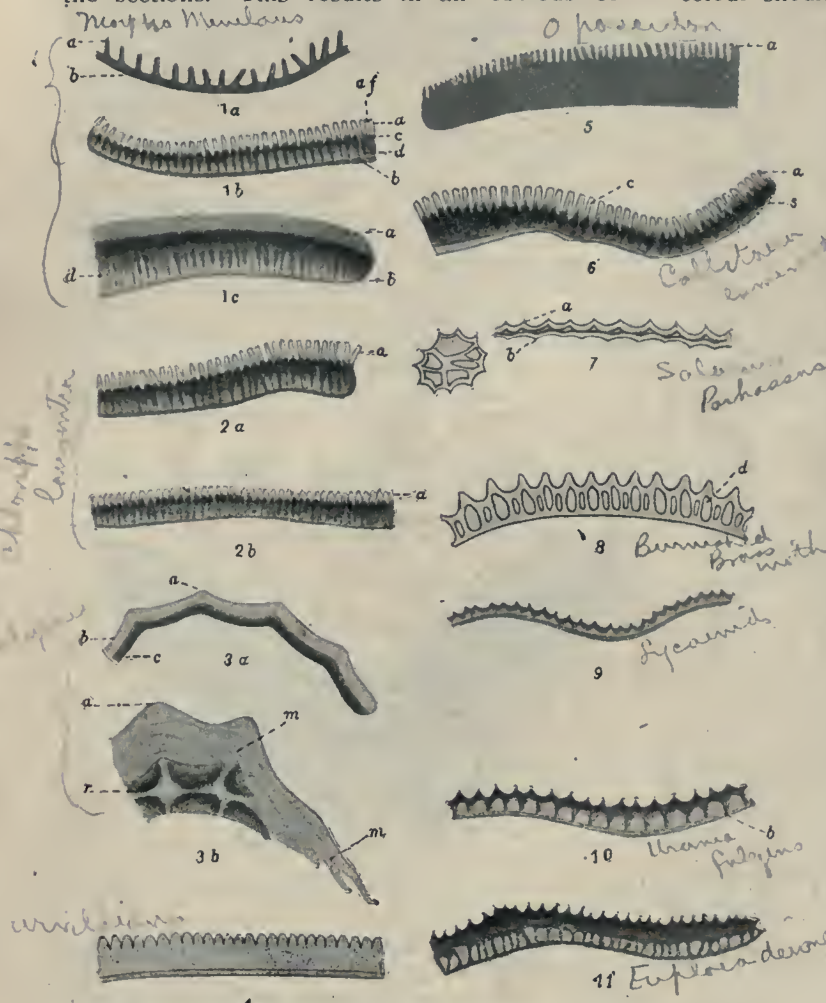


Fig. 2.

1a, Upper scale of *Morpho menelaus*. *a*, striæ; *b*, lower membrane.
1b, Lower scale of *M. menelaus*. *af*, air-film; *a*, chitin film; *c*, pigmented striæ; *d*, bands of chitin joining upper and lower membranes; *b*, lower membrane.
1c, Longitudinal section of the last. *a*, chitin film seen from the side.
2a, Central spot of *Chlorippe laurentia*. *a*, tall films of chitin.
2b, Periphery of the above, showing *a*, bosses of chitin.
3a, Scale of *Papilio ulysses* showing *a*, wave-like striæ; *b*, transparent layer of chitin; *c*, pigmented layer of chitin.
3b, Diagonal section of the same. *a*, striæ; *r*, pigmented portion of striæ; *mm*, films of chitin.
4, Blue scale of *Ornithoptera urvilliana*. The chitin is colourless.
5, Green scale of *O. poseidon*. The whole scale, including the chitin films *a*, contains a yellow pigment.
6, Magenta scale of *Callitaera esmeralda*, showing granular pigment *s*; and a cleft, or division *c*, in the films of chitin *a*.
7, Section through scale, and tip of scale of *Salamis parhassus*. *a*, upper membrane; *b*, lower membrane.
8, Metallic golden scale of *Dione juno*. *d*, large air-space.
9. Iridescent scale of *Lycaena icarus* stained with carbol-fuchsin.
10, Black under-scale of *Urania fulgens*. *b*, transparent, iridescent membrane.
11, Partially depigmented scale of *Euploea deione*.
All these sections were drawn to the scale $\mu = 1{\cdot}5$ mm. with Zeiss 2 mm. apochromat, N.A. 1·4, and Comp. Oc.

The variation of colour in a number of insects was measured in wave-lengths, and most of them were found to fall into two groups—(a) those with the periodic structure just described, which at grazing incidence reflected the longest waves, and (b) those without this structure, which reflected the shortest waves when in the same position. Further, it was possible to show that the distance between two consecutive plates of chitin was from $0{\cdot}6\mu$ to $1{\cdot}0\mu$,[2] and since the chitin plates often show a line of cleavage, c, Fig. 2, section 6, so that they appear double, this space may contain two films of chitin and one of air. Thus the plates may be of the most efficient thickness for producing colour (*i.e.* one-half wave-length), which for chitin is $0{\cdot}17\mu$, and for air $0{\cdot}25\mu$, or $0{\cdot}6\mu$ for the three plates.

Chlorippe laurentia.—The edges of the dull green patches on this insect's wings are brown at normal incidence, but the whole area becomes a brilliant green at grazing incidence. This illustrates the effect of the height of the chitin plates on the quality and saturation of the colour. The central area, which is always green, is shown in section $2a$, Fig. 2, where the chitin plates are the usual height. In the area which is brown at normal incidence, section $2b$, Fig. 2, the chitin plates, a, have become merely bosses. If a ray must traverse three or four films to give a certain depth of colour, it is obvious that, in the case of section $2b$, it will do this only at very oblique incidence; whereas, in section $2a$, this will happen with rays more nearly normal to the surface.

Ornithoptera poseidon (Fig. 1).—The males of this gorgeous species, and of the even more remarkable *O. paradisea* (Fig. 3), are emerald-green, and they illustrate the effect of combining structural and pigmentary colours. The narrow plates of chitin, a, seen in section 5 of Fig. 2, produce a blue colour, but the body of the scale is dyed by a bright yellow pigment, the colour of picric acid. This pigment extends into the chitin

[2] $1\mu = \frac{1}{1000}$ mm. The sections in Fig. 2 were all drawn to the scale $\mu = 1{\cdot}5$ mm., so that the relative distances may be seen at a glance.

plates themselves, so that they also are yellow. The addition of this pigment converts the blue into a green, and the effect of suppressing it is seen in *O. urvilliana*, a powdery blue insect, a section of which, *4*, is shown in Fig. 2. It is pale blue on the upper surface, probably because the chitin plates are broad, but underneath, where the plates are like those in section 5, and contain a little yellow pigment, it is pale green. In some other insects

FIG. 3.—*Ornithoptera paradisea* ♂. Body and hind-wings gold fore-wings green and black. (½ natural size.)

the pigment is granular, as at *s*, in section 6, being situated in the body of the scale, but not in the chitin plates. This is the case with those Pierids which have magenta tips to their fore-wings, as well as with the beautiful purple-eyed *Callitaera esmeralda*, which has scaleless but iridescent fore-wings (Fig. 5).

FIG. 4.—*Nomiades arion* (the Large Blue) Male and female, and under sides of same. (Natural size.)

Black is naturally a very important pigment, for it often serves the purpose of absorbing white light, which otherwise, being reflected, would greatly desaturate the colour. Thus the white spots in many insects, such as *Morpho cypris*, have exactly the same structure as the deep blue parts, except for the absence of the absorbent backing of black pigment in the lower layers of the scale.

Papilio ulysses.—The insects the colour of which changes towards the violet at grazing incidence do not have a periodic structure such as that described; but they invariably exhibit a somewhat thick superficial layer of clear chitin. The scales of many iridescent Papilios belong to this group, as, for example, the satin-blue scales of *P. ulysses*, section *3a*, Fig. 2. The layer of chitin, *b*, is clearly too thick to cause colour, and no finer structure could be made out, even with an objective capable

FIG. 5.—*Callitaera esmeralda*. The wings are scaleless and faintly iridescent. The eyes of the hind-wings are magenta. (Natural size.)

of separating the rulings of a grating 0·21μ apart. This is less than one-half the mean wave-length in air, which seems to preclude the existence of air-films. Nevertheless, the surface layer might contain three or four half-wave-length plates of chitin, placed exceedingly close together, though not actually in optical contact. It is, however, doubtful whether in this case pressure experiments and immersion in highly refractive fluids would produce the effects observed.

Very strong confirmation of the existence of a periodic structure, of some description, parallel to the surface, can be obtained by cutting oblique sections of *P. ulysses*. These sections, *3b* (Fig. 2), show the ragged edges of three or four layers of chitin, *mm*, which come into focus successively on lowering the objective.

Salamis parhassus.—There are some insects, like the pale pink *Salamis parhassus*, which have scales that might owe their colour to the thin double membranes of which they are composed, *a* and *b*, section 7 (Fig. 2). If these single films of chitin really cause the colour, it is difficult to account for the uniformity of shade, which ought to vary with the inevitable differences of thickness inherent in an organic film. Such variegated colours are actually found in the lower membrane of many black scales, such as those of *Urania fulgens*, *b*, section 10 (Fig. 2).

There are, however, other insects, such as many Lycænids (Figs. 4 and 6), the iridescent scales of which have membranes too thick to produce colour, though no finer structure can anywhere be made out, section 9 (Fig. 2).

Euploea deione.—There is one large group of

FIG. 6 *Lycaena corydon* (the Chalk Hill Blue). Male, female, under-side of female and larva. (Natural size.)

insects of considerable interest, the colour of which cannot be accounted for in any way. This group includes the dark purples and deep, glossy blues and greens of all the most sombre iridescent insects, such as the Purple Emperor (*Apatura iris*), the Scarlet Tiger (*Callimorpha dominula*), the Purple Hairstreak (*Zephyrus quercus*), and many exotic species. Any one of these, such as the section of *Euploea deione*, *11* (Fig. 2), shows no difference from the black, non-iridescent scales immediately beneath them. They are all so densely pigmented that nothing can be made out until they are bleached, and even then a thin cuticle only sometimes appears. Were it not for the fact that the colours disappear under pressure and in refractive fluids, it might be thought that the iridescence was due to selective metallic reflection, as will be shown to be probably the case in most scaleless beetles.

Dione juno.—Scarcely less puzzling are the metallic greenish-gold and silver scales of many Plusia, such as the Burnished Brass Moth (*Plusia chrysitis*). Section 8, Fig. 2, shows the golden scale of the tropical insect *Dione juno,* which has no structure that can adequately account for the colour, since it is identical with the scales in the adjoining brown areas, except for the absence of the pigment. To produce anything approaching metallic reflection a highly polished surface would be necessary, as well as a large number of air-spaces not more than the diameter of a few air-molecules in thickness. The effect of a highly polished surface is seen in the scales of the Coppers, as, for instance, the Small Copper (*Chrysophanus phlaeas*), which has ordinary scales containing a granular orange pigment, yet appearing almost iridescent. The only trustworthy evidence of true iridescence is, of course, the change of colour seen on altering the angle of the incident light.

(*To be continued.*)

Ballistic Calculations.

By D. R. HARTREE.

THE purpose of the present article is to give an outline of the more important methods of numerical solution of the various problems of external ballistics—that is to say, problems connected with the resisted motion of a shell after leaving a gun. Most of the methods to be mentioned were developed during the war, either for working out range tables or other information to be used in the field, or for analysing a trial shoot.

The problems that arise may conveniently be divided into two groups, comprising what are sometimes known as primary and secondary problems, the theoretical and practical treatments of which proceed on rather different lines. The primary problems are those which involve the calculation of the performance of a gun, or rather its shell, under ideal conditions, such as still air, a standard muzzle velocity, and so on. The secondary problems are those in which we are concerned with the calculation of the corrections to be applied to the solutions of the primary problems to allow for the departure of actual conditions from the ideal.

A very important simplification is introduced by assuming that the forces due to the motion of the shell through the air consist only of a resistance in a direction opposite to the direction of the motion of the shell relative to the air. Lack of trustworthy information until recently about the other forces made this the only possible course. Some account of these forces and their effects is given in a recent issue of NATURE.[1]

Making this assumption, and neglecting the effect of earth rotation (which may be considered as a secondary problem), it appears that the trajectories concerned in any primary problem lie entirely in the vertical plane containing the initial direction of motion. For this reason they are known as "plane trajectories."

The retardation due to air resistance R acting

[1] See NATURE, June 10, "The Dynamics of Shell Flight," by R. H. Fowler.

on a shell of mass m is usually expressed by the formula :—

$$\frac{R}{m}=\frac{F(v)}{Cf(y)},$$

where v is the velocity of the shell relative to the air, $f(y)$ is the reciprocal of the density of the air at height y, $F(v)$ is an experimentally determined function of the velocity, and C depends on the size and shape of the shell.

Standard functions $F(v)$ and $f(y)$ are used in all ordinary calculations; the quantity C is determined for any particular shell by comparing the results of firing trials with trajectories calculated for the same muzzle velocity and elevations as used in the trial, and two or three values of C.

Primary Ballistic Problems.

Before the advent of the anti-aircraft gun the point of fall was the only point of a trajectory of any great practical importance, and this could be found to a certain degree of accuracy by means of approximate integrals of the equations of motion, for high-velocity guns at small elevations, and for low-velocity howitzers at high elevations, which were the two cases of importance before the war.

But when guns began to be used at higher elevations, and the muzzle velocities of howitzers were increased, these approximate solutions became unsatisfactory; also, with the development of the anti-aircraft gun, came the necessity for calculating whole trajectories, instead of merely a point on each trajectory. Later, it was found necessary to know the whole trajectory, even for guns only intended for use against targets on the ground, in order to solve certain secondary problems, such, for example, as the wind correction to be applied when the wind varied with the height.

The equations of motion, even of the plane trajectory, are formally insoluble, which is not surprising, considering that the air resistance which enters into them contains two functions, $F(v)$ and $f(y)$, of an empirical nature. The only really satisfactory way of obtaining numerical solutions is to carry out a numerical integration of the equations of motion.

To perform this integration a step-by-step method is employed. That is to say, the trajectory is divided up into a series of fairly short intervals, and the integration through each interval in turn performed by means of suitable approximate formulæ, the size of the interval being chosen to make the errors negligible. The complicated way in which the different variables are connected makes it impossible to use directly any of the ordinary integration formulæ, such as Simpson's rule.

Methods of step-by-step integration have, of course, long been known in astronomy; they seem, however, to have been regarded until recently as too laborious for ballistic work except in special cases. However, during the war those concerned with ballistic calculation were forced to use them, for reasons already mentioned, and gradually with experience methods were evolved which were both simple to carry out and not too lengthy. The use of a series of intervals of the same length, and of the finite differences of various quantities at the ends of successive intervals, both simplifies the integration and makes possible a complete check on the numerical work.

When two or more trajectories of the same gun with different elevations have been calculated by these methods, it is obviously possible to determine intermediate trajectories by interpolation. Theoretically, interpolation methods are of a subsidiary nature; in practice, if simple and accurate, they are often very useful.

For a range table, or for the graduation of sighting apparatus, either for flat or high-angle fire, interpolation from the data furnished by the calculation of trajectories is necessary.

Thus in a flat range table the elevation necessary to reach a given range is tabulated as a function of the range, but in calculating a trajectory an exact value of the elevation is taken, and the range is found. The interpolation in this case is usually done graphically.

For a high-angle range table the question is more complicated, for this table is one of double entry, giving the elevation required to reach various points in a two-dimensional region. A table obtained by graphical interpolation usually needs some smoothing. This process, though fairly simple for a single entry table, is almost prohibitive for a table of double entry. A scheme of accurate numerical interpolation was therefore evolved; this scheme as a whole is rather elaborate, but the individual calculations are very simple.

In England the greater part of the numerical work of ballistics is carried out by means of calculating machines.

Secondary Ballistic Problems.

The development of the methods of solution of the secondary problems in general arose in the first place from the necessity of finding the effect of a wind, or change of atmospheric density from standard, which varied along the trajectory. These are the most important secondary problems in practice, but the methods can be extended to others with little difficulty.

To make the problem more manageable, only "first order" effects of applied variations are considered. That is to say, it is assumed that the effects of such variations are additive, so that, for example, the effect of a given wind and a given change of atmospheric density acting together is the sum of the effects of each separately. In cases of practical importance the error is probably very small.

The problem of calculating the effect of a wind variable along the trajectory is generally divided into two parts, the determination of the effect of unit constant wind, and the determination of the "equivalent constant wind"—*i.e.* the constant wind which produces the same effect at the same time. The latter is obtained by means of a set of "weighting factors" which express the relative importance of the wind at different parts of the trajectory.

Considering the wind effect at any given point, the weighting factor for any section of a trajectory is the ratio of the effect at that point of unit wind blowing in that section only to the effect at the same point of unit wind blowing throughout the trajectory. If W is the actual wind in any section, and k is the weighting factor for that section, then the equivalent constant wind is given by the sum of the values of kW for all sections up to the point where the effect of the wind is being considered.

The same arguments apply to variations of atmospheric density from standard. An account of the application of weighting factors has appeared in a recent number of NATURE[2]; we are concerned here with the calculation of them.

The values of the weighting factors for given sections depend on the point at which the effect of a wind (or change of density) is being calculated, and on the precise effect which is being considered. For example, a wind in the plane of the trajectory produces changes in both horizontal and vertical co-ordinates of the point reached in a given time, and if the wind varies along the trajectory the constant wind which will produce the same horizontal displacement will not generally produce the same vertical displacement.

The four equations of motion of the plane trajectory express the relations between the components of velocity, the co-ordinates, and the time. From them can be obtained, by a process analogous to differentiation, four "equations of variation" expressing the relations between the changes in these quantities, for a given time, for any change in conditions which causes first order variations in the plane of the trajectory. (A cross-wind produces only second order effects in this plane, and its treatment is entirely separate.)

The equations of variation have no formal solution, and step-by-step integration is necessary for numerical work. To find wind weighting factors, the obvious method is to integrate the equations for winds blowing in the sections for which weighting factors are required; but this is not necessary, for if the integration is performed for three suitable changes of conditions, the results may be combined to give weighting factors, not only for wind, but for density changes as well.

The numerical work of the process of combining the three solutions is rather heavy and not altogether simple, and a more direct way of calculating weighting factors has been worked out. The equations of variation form a system of linear differential equations of the first order, and by using a certain property of such a system another set of equations (the "adjoint" system) can be obtained, the solutions of which give directly the effect at a given time of a constant wind (or density changes) which begins at a previous variable time. Weighting factors are obtained at once by dividing by the effect of a constant wind which begins at the origin, and differencing the results.

The equations of variation may be applied to any problem in first order variations. The subject of second order variations has not been developed, as its practical importance appears small.

[2] NATURE, June 17. "The Importance of Meteorology in Gunnery," by Dr. E. M. Wedderburn.

Obituary.

THE study of earthquakes in New Zealand and Australia has suffered a serious loss through the death of MR. GEORGE HOGBEN on April 20 last. For many years Mr. Hogben acted as secretary of the seismological committee of the Australasian Association for the Advancement of Science, and we are indebted to him for reports of this committee, and for many studies of individual earthquakes published in the Transactions of the New Zealand Institute and other journals. It was owing to his efforts that the Milne seismograph was erected at Wellington, N.Z., and that, shortly before his death, an order was given for the improved Milne-Shaw seismograph. In addition to his contributions to our knowledge of earthquakes, Mr. Hogben was interested in education generally, and was for two years president of the Wellington Philosophical Society. According to a notice issued with the Hector Observatory Bulletin (No. 28, 1920), he also issued a valuable report on proportional representation, and at the time of his death had an improved set of mathematical tables in the press.

THE *Atti dei Lincei* (vol. xxix. (1), parts 9–10) contains an obituary notice by R. Versari on the late PROF. FRANCESCO TODARO. Born at Tripi (Messina) on February 14, 1839, Todaro entered the University of Messina in 1860, but on the entry of Garibaldi he took up arms as a volunteer in the Chasseurs of Etna. On the conclusion of hostilities and of service to the wounded, he returned to the University, and was attracted by the German biologists to anatomical and physiological studies. He went for some time to study at Florence under Schiff and others, and in 1865 published his first paper on the muscular system of the human heart and the Eustachian valve. He returned to Messina as professor of human anatomy, and in 1869 gave an address on the renewal of the human body. Todaro was among the earliest to study the anatomy of the lower marine animals, and to realise, in accordance with the doctrine of evolution, the importance of comparative anatomy as throwing light on the anatomy of man. In 1870 he read a paper on the sense-tubes of Plagiostomata, and the following year was invited by Brioschi to the chair of human anatomy at Rome. Shortly afterwards he concentrated his attention on the development and anatomy of the Salpidæ, discovering many new organs. His first paper on this group appeared in 1875, and his last is in proof. Todaro also published papers on the fertilisation and segmentation of *Seps chalcides*. Being the first to advocate the introduction of gymnastics in Italian schools, he was elected president of the Italian Gymnastic Federation, in which capacity he delivered several inaugural discourses at meetings and reunions.

AMONG the many skippers and hunters of northern Norway who have taken part in Arctic exploration one of the best known was HANS CHRISTIAN JOHANNESSEN, whose death at Tromsö at the age of seventy-four is announced by the *Times*. During his sealing and walrus-hunting in the Barents Sea Capt. Johannessen many years ago visited the little-known Wiche Islands to the east of Spitsbergen and the coasts of North-east Land. At a later date he hunted off Novaya Zemlya and Franz Josef Land, penetrating westward to White Island and Spitsbergen. But Capt. Johannessen's principal work was in the navigation of the Kara Sea and the opening of a sea route between Europe and Siberia. When Baron Nordenskjöld sailed in the *Vega* in 1878 to do the North-East passage he was accompanied by the small steamer *Lena* under the command of Capt. Johannessen. Without the help of a pilot Johannessen took the *Lena* safely through the difficulties of the Lena delta, and ascended the river for more than 1700 miles to Nyuiskaya, eventually returning to Yakutsk. This was the first steamer to reach Siberia by this route. Johannessen returned overland, and the *Lena* is still in service on the river. Capt. Johannessen piloted many other vessels through the Kara Sea to the Yenisei River. In 1883, in the *Nordenskjöld*, he rescued the crew of the Dutch expedition in the *Varna*, crushed in the Kara Sea. In the *Gjoa*, which he afterwards sold to Amundsen for his North-West passage expedition, Johannessen made many successful hunting expeditions to the Far North.

DR. DUCKWORTH gives in the September issue of *Man* an account, with a full catalogue of his writings, of the eminent Italian anthropologist, MAJOR-GEN. RIDOLFO LIVI, whose death on April 12 last was a serious loss to science. Gen. Livi is best known by his great work, "Anthropometria Militare," published in 1896–98, which deals mainly with the question of physical development in relation to fitness for military service. He was also author of a manual of anthropometry of wide scope and originality, and of a treatise on domestic slavery in Italy in medieval times. Gen. Livi died at the age of sixty-three, his degrees in medicine and surgery being taken in 1878, when he entered the Army. He served in the African campaign of 1887–88 as well as in the recent war, holding at the time of his death the rank of major-general, to which he was promoted in 1917.

WE much regret to announce the death on September 27, at fifty-seven years of age, of MR. D. H. NAGEL, Vice-President and Senior Tutor of Trinity College, Oxford.

Notes.

A SPECIAL conference has been called together by the Royal Society to consider the future of the International Catalogue of Scientific Literature. The conference held its first meeting at Burlington House on September 28, Sir Joseph Thomson in the chair. The following is the list of delegates:—Sir David Prain, Sir Arthur Schuster, Mr. J. H. Jeans, Prof. H. E. Armstrong, Dr. F. A. Bather, and Dr. P. C. Mitchell, representing the Royal Society; Prof. M. Knudsen, Denmark; M. A. Lacroix, France; Dr. G. van Rijnberk, Holland; Prof. R. Nasini and Comm.-Ing. E. Mancini, Italy; Dr. H. Nagaoka, Japan; Mr. R. Laache, Norway; Baron Alströmer, Sweden; Dr. H. Escher, Dr. M. Godet, and Dr. H. Field, Switzerland; Dr. R. M. Yerkes, Dr. L. E. Dickson, Mr. L. C. Gunnell, and Dr. S. I. Franz, U.S.A.; Sir Henry Hayden and Dr. S. W. Kemp, India; Sir Thomas Muir, South Africa; Sir Edward Parrott, Queensland; Prof. E. W. Skeats, Victoria; Mr. C. B. Rushton, Western Australia; and Prof. A. Dendy, New Zealand. The delegates were the guests of H.M. Government at a dinner at the Carlton Hotel on September 29.

WE understand that Mr. Reid Moir, during his investigations of the north-east coast of Norfolk, has made an important discovery in the neighbourhood of Cromer. It appears that a flint-workshop site, apparently of Early Chellian Palæolithic age, occurs at this place at an horizon referable to one of the lower members of the Cromer Forest Bed series. The site, though limited in extent, is very rich in humanly fashioned flints, and Mr. Moir hopes in the near future to exhibit and describe the large number of specimens he has collected.

THE MINISTER OF HEALTH has appointed a Committee to investigate and report on the causes of blindness, including defective vision sufficient to impair economic efficiency, and to suggest measures which might be taken for the prevention of blindness. The members of the Committee are:—Mr. G. H. Roberts, M.P. (chairman), Mr. Stephen Walsh, M.P., Mr. N. Bishop Harman, Dr. J. B. Lawford, Mr. G. F. Mowatt, Mrs. Wilton Phipps, Mr. J. H. Parsons (representing the Royal College of Surgeons), Dr. J. Taylor (representing the Royal College of Physicians), Mr. J. C. Bridge (representing the Home Office), Dr. A. Eicholz (representing the Board of Education), Mr. J. S. Nicholson (representing the Ministry of Labour), Mr. W. M. Stone (representing the Scottish Office), Mr. E. D. Macgregor (representing the Ministry of Health), and a representative of the Medical Research

Council (to be appointed later). Dr. R. A. Farrar and Mr. P. N. R. Butcher will act as joint secretaries to the Committee, and any communications should be addressed to them at the Ministry of Health, Whitehall, London, S.W.1.

SIR FREDERICK ANDREWES, professor of pathology in the University of London, will deliver the Harveian oration of the Royal College of Physicians on Monday, October 18, at 4 p.m.

MR. J. D. FRY, lecturer on physics at the University of Bristol, and Mr. A. Hessell Tiltman have been appointed to the scientific staff of the Research Association of British Rubber and Tyre Manufacturers.

THE third annual Streatfeild memorial lecture will be delivered by Mr. J. H. Coste at the City and Guilds Technical College, Leonard Street, E.C.2, on Thursday, October 14, at 4 p.m. The subject will be "The Gases Dissolved in Water." Admission will be free.

Science for September 10 announces that it is proposed to establish in Panama an international institute for research on tropical diseases as a memorial to the late Major-Gen. W. C. Gorgas. Panama has been chosen in view of the fact that Gen. Gorgas's most noteworthy work was accomplished there.

WE learn from the *British Medical Journal* that the Hughlings Jackson lecture of the Section of Neurology will be delivered at the Royal Society of Medicine by Dr. H. Head on October 7 at 8.45 p.m. Dr. Head has chosen as his subject "A New Conception of Aphasia."

THE British Cutlery Research Association has been approved by the Department of Scientific and Industrial Research as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. The secretary of this association is Mr. J. M. Denton, P.O. Box 49, Sheffield.

CERTAIN friends of Mr. W. F. Denning and admirers of his lifelong devotion to astronomy have contributed a sum of about 300*l.* to a fund which has just been established for him. Mr. Denning has been sent 50*l.* to meet his immediate necessities, and the balance remaining in hand has been paid over to Sir Frank Dyson and Col. E. H. Hills in trust for Mr. Denning, with directions to pay him the sum of 50*l.* annually. Should it be necessary, further subscriptions will be raised in order that a payment of this amount may be secured to Mr. Denning as an annuity for life.

THE Cryptogamic Society of Scotland held its first annual gathering since the war on September 21–23 at Perth. Under the leadership of the secretary, the Very Rev. Dr. D. Paul, of Edinburgh, and Mr. Jas. Menzies, of Perth, the society made excursions to Murthly on the first day and to Invermay on the second, where the dominant species found was *Tricholoma saponaceus*; here the dog-stink horn, *Mutinus caninus*, turned up again, having been recorded many years ago, since when it had not been seen; also in the woods, below a fir-tree, the curator of the Perth Museum, Mr. J. Ritchie, was fortunate in finding *Collybia ludius*, Fr., this being a new species recorded for Britain. The last day's excursion was to Methven, where the outstanding species numerically were *Lactareus vellereus* and *Craterellus cornucopoides*.

THE forthcoming general discussion on "The Physics and Chemistry of Colloids and their Bearing on Industrial Questions," which is being arranged jointly by the Faraday Society and the Physical Society of London, has been fixed for Monday, October 25, at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1. The discussion will be presided over by Sir W. H. Bragg, and it will be introduced by Prof. The Svedberg, of the University of Upsala, who will give a general survey of the subject before discussion is opened in its various branches. Non-members of the above societies desirous of attending the discussion may obtain tickets of admission from Mr. F. S. Spiers, 10 Essex Street, London, W.C.2. The Faraday Society, the Institution of Mechanical Engineers, the Institute of Metals, and probably also the Iron and Steel Institute contemplate holding early in 1921 a joint general discussion on "The Failure of Metals under Internal or Prolonged Stress."

IT is announced that the British Antarctic Expedition, which Mr. John L. Cope has been organising for some time, has left England for its base at Port Stanley, in the Falkland Islands. Other members of the expedition are Capt. Wilkins, Mr. W. T. Bagshawe (geologist), and Mr. M. C. Lester (navigator and surveyor). The *Times* states that from the Falkland Islands the expedition will be taken by a whaling vessel to the Weddell Sea, and there landed on the ice during January. The party hopes to survey hitherto unexplored regions, but no attempt will be made to reach the Pole, the aims of the expedition being purely geographical and biological. At the end of eighteen months or so the party will return to England, by which time a specially built ship and a large aeroplane will be ready for a further expedition, which is expected to be of five years' duration.

A SMALL but interesting exhibition of books, manuscripts, and relics illustrative of the life and work of Gilbert White was held on September 24–25 at the Art Workers' Guildhall, Queen Square, W.C.1. The exhibition concluded the bicentennial celebration of the birth of the Selborne naturalist organised by the Gilbert White Fellowship. A fine series of modern water-colours of Selborne and of Ringmer adorned the walls of the hall. Upon the tables there were laid out for inspection a large number of editions of "The Natural History and Antiquities of Selborne," together with somewhat rare contemporary works upon subjects discussed by Gilbert White. Microscopy also received attention, while living specimens illustrative of the life of the mosquito aroused considerable interest. In an address delivered by Dr. Gilbert White, Bishop of Willochra, North Australia, and great-grandnephew of Gilbert White, reference was made to the life and work of the naturalist as emphasising the value of a study of Nature—a study which opened out a realm of interest and knowledge untouched by changes in human life and environment.

Nature-study for its own sake was comparatively modern; the earliest writers, such as Pliny the Elder and St. Basil, looked towards the marvellous and the utilitarian, while passages by St. Gregory depicting scenery and the beauty of the country were exceptional. Gilbert White inculcated a love of Nature which might be regarded as a revelation of Divine intelligence. With reference to the "Natural History," Dr. White spoke of its many editions, exceeding in number, so it was said, that of any other book excepting the Bible and "The Pilgrim's Progress." Its popularity was continuous and progressive; it illustrated the steady and quiet devotion still being given to the study of Nature.

At the meeting of the Association of Economic Biologists held at Kew on September 24 the subject discussed was that of immunity to fungus diseases in plants. The president, Sir David Prain, was in the chair. Mr. E. S. S. Salmon dealt with the relation of climatic factors, and directed attention to those cases where immunity broke down under certain weather conditions. His observations showed that the wild hop comprises numerous physiological forms with distinctive "constitutional" characters with regard to mildew, ranging from extreme susceptibility to immunity. The immune forms when grown in the greenhouse remained immune; when grown in the open, with warm, sunny weather, immunity is retained; with low temperatures and lack of sunshine there is a temporary loss of immunity. Climatic factors would appear to influence also the degree of immunity of certain wheats to "rust." Mr. F. T. Brooks spoke on the question of inheritance of disease resistance, and dealt chiefly with the work of Biffen and Armstrong on *Puccinia glumarum*. Although susceptibility and immunity behave as a pair of allelomorphic characters segregating in Mendelian fashion, it was pointed out that the "genetic constitution" of "immune" plants is liable to modification within narrow limits by environmental conditions, so that a family rust-free one year may be slightly affected by rust another season. Rust-resistance in wheat behaves as a simple Mendelian recessive, but there is evidence that resistance to mildew, on the other hand, acts as a dominant character. A brief analysis of the meanings attached to the use of the word "immunity" in plant pathology was made. A *résumé* of a paper by Mr. A. Howard on the importance of soil factors in bringing about epidemics was read. In the discussion Dr. N. L. Britten and Dr. E. J. Butler spoke of conditions in America and India respectively. Members were entertained to tea by the president, and afterwards visited the Botanic Gardens.

Among the Turkana tribe in the Sudan, according to a writer in *Sudan Notes and Records* (vol. iii., No. 3), a curious system of recording prowess in war is in force. When a man has killed an enemy a number of incisions are made on the victor's body to record the fact, those on the right side indicating that the victim was a man, those on the left a woman. A hook is inserted in the skin, a portion of which is raised, in which a cut about half an inch long is made. Fat and clay are then rubbed in until the man can endure no further pain. The endurance of this people may be measured by the fact that many of them are covered from waist to shoulder with such marks. It is only on the first occasion when an enemy has been slain that these marks are made, later deeds of valour being left unrecorded.

The question of the origins of the Babylonian and Assyrian scripts has been again raised by M. G. C. Teloni in an article entitled "L'écriture babylonienne et assyrienne" in *Scientia* (vol. xxviii.) for 1920. After a full review of various speculations, M. Teloni thus summarises his conclusions: "Les théories exposées dans les pages précédentes, et qui sont celles qui prévalent aujourd'hui au sujet de l'origine de l'écriture babylonienne-assyrienne, se rapportent principalement aux monuments d'épigraphie sumériens et sémitiques du bassin de l'Euphrate et du Tigre. Il n'a été, jusqu'à aujourd'hui, examiné au service de cette question que bien peu d'autres inscriptions appartenant au système cunéiforme. On peut attendre beaucoup d'un examen approfondi des signes élamites (anciens et modernes), vannico-assyriens et persans; en particulier, le syllabaire élamite, rival du babylonien au point de vue d'antiquité, et le syllabaire persan cunéiforme, dont la dérivation de Babylone apparaît de jour en jour plus contestable, promettant de faire la lumière sur l'histoire générale de l'écriture cunéiforme."

An account of a remarkable sculpture recently found on a capstone of a dolmen at Déhus, in the parish of the Vale, Guernsey, is given in the September issue of *Man* by Lt.-Col. T. W. M. de Guérin. The figures consist of a face and two hands, with the outlines of a portion of both arms. Below these is a mark possibly representing the girdle so often found on French statue-menhirs. Anthropomorphic figures very similar to that of Déhus are found in France sculptured on the props of the Late Neolithic dolmens of the valleys of the Seine and Oise, and also of Collorgues, in the Department of Gard, while very similar figures have been noticed in the grottoes of Le Petit Morin, Marne, which are believed to date from the Æneolithic period. It is now certain that the cult of the divinity represented by the figures on the Déhus dolmen and the statue-menhir of the Castel lasted from early times in Guernsey, for the second statue-menhir, now standing as a gate-post at the Church of St. Martin, is of much later date than that of Castel. It is one of the largest and best-preserved statue-menhirs in existence, far surpassing in style and execution those of south-eastern France.

Sir James Frazer in a letter to the *Times* of September 22 gives a further report of the progress of the Mackie Expedition to East Africa conducted by the Rev. John Roscoe. The expedition has been at work among the Banyoro of Lake Albert in the Uganda Protectorate. This tribe or nation is composed of two ethnical strata, the Bahuma, a ruling caste of herdsmen of Hamitic stock, and the Bairu, a subject agricultural peasantry of Bantu stock. The whole life of the Bahuma king is devoted to ceremonial observances of a priestly or magical character for the good of the people, their cattle, and their land. Consequently he is seldom, or never, able to quit the enclosure in which he resides. An interesting custom once was the annual raising of an agricultural peasant to the kingly rank, representing the real king's dead father. After a period of about a week, during which he lived at the tomb of the dead king, treating the royal widows as his own wives and blessing the real king and the country in the name of the dead man, he was taken to the back of the tomb and strangled.

THE report of the director of the New York Aquarium, reprinted from the twenty-fourth Annual Report of the New York Zoological Society, is chiefly concerned with the unsatisfactory condition of the building. Mr. Townsend has our sympathy, but he arouses our interest more by two brief paragraphs. One of these states that the large crayfish of the Columbia River was safely transported alive from California to New York in wrappings of damp paper. The other ascribes the total disappearance of the sea-horse (*Hippocampus hudsonius*) from local waters to the unusually severe winter of 1918. The report describes and illustrates ingenious gravity filters and strainers and air-compressors used when sending fishes by train or ship.

THE Davidson collection of recent Brachiopoda in the British Museum has hitherto been regarded as taking the lead, but, at all events in point of numbers, it is now outclassed by the collection in the United States National Museum, of which Dr. W. H. Dall has lately published an "Annotated List" (Proc. U.S. Nat. Mus., vol. lvii., pp. 261–377). The latter contains more than six thousand specimens, representing 181 different forms, of which thirty-three are here introduced as new. These fall into some fifty genera. The ordinary zoologist will regret to see some apparently inevitable changes in well-known names: thus *Lingula anatina* becomes *L. unguis*, Linn.; *Terebratulina caput-serpentis* having been based on a fossil of different structure, the name *T. retusa*, Linn., must be adopted for the recent species; and Liothyrina gives place to Gryphus. Among interesting facts of distribution are noted the discovery off the Californian coast of two Japanese species, *Terebratulina crossei* and *T. kiiensis*.

AN interesting discussion arises in Dr. N. Annandale's "Observations on 'Physa Prinsepii,' Sowerby" (Rec. Geol. Surv. India, vol. li., p. 50, 1920), as to the cause of extinction of this giant planorbid some time after the intertrappean (late Cretaceous) epoch in India. The genus Bullinus (formerly Bulinus, Adanson), to which this shell is now transferred, survives in Africa, the Malay Archipelago, and Australia, in conditions apparently less favourable than those surrounding the fossil forms in India. Dr. Annandale suggests that exceedingly congenial surroundings led to an overgrowth of the mollusc (which attains 76 mm. in height), and that it was unable to survive any reduction of the luxury that it had long enjoyed.

IN connection with blood-transfusion experiments during the war it was found that severe reactions sometimes followed the intermingling of the blood of certain individuals. Previous work, in which human sera were classified into four groups according to their iso-agglutinating actions, was therefore very useful in determining between which individuals transfusion could safely take place. In a short paper by Mr. J. R. Learmonth (*Journ. Genetics*, vol. v., No. 2) the author has studied the blood reactions of a number of families, and concludes that the iso-agglutinins are inherited, two pairs of Mendelian factors being concerned. But it appears from observations by Bond that iso-agglutinins which are absent from the serum of a given individual may appear after the patient has reacted to a systemic infection. It has been suggested that these serum reactions might be used as a legal proof of illegitimacy.

IN two papers in the *Journal of Genetics* (vol. x., No. 2) Mr. F. L. Engledow deals with the inheritance of the various forms of lateral florets and rachilla in barley and length of glume and grain in a hybrid wheat. A bristly rachilla is dominant to smooth, and it is suggested that the same factor governs the type of hair in other parts of the flower, and may also be concerned with the development of the root-hairs, which would affect the yield. The barleys differ in the form of their lateral florets, six-row and two-row barley differing by a single factor, the heterozygotes being intermediate with some fluctuations in expression. These fluctuations are found to be environmental in origin, and not a case of mosaic inheritance. In a cross between Polish and Kubanka wheat long and short glumes behave as a pair of characters, the F_1 being intermediate. But the interesting result is obtained that in the extracted "longs" the length of glume is reduced by nearly 25 per cent. in comparison with the long-glumed parent, and this shift or modification remains true in the F_3. Similar results were obtained with grain-length, the long grain being reduced by 12·5 per cent. in the extracted F_2's. These two pairs of characters are inseparable in inheritance, length of grain unexpectedly behaving as a maternal character, although it must be partly determined by the character of the endosperm. Possible explanations of these results are discussed.

SOME very fine views of glaciers in Canada occur in Dr. C. D. Walcott's "Geological Exploration of the Canadian Rockies: Field Season of 1919," extracted as a pamphlet from "Explorations and Field-Work of the Smithsonian Institution in 1919." The photograph of the environs of the Mount Lyell Glacier makes a folding plate nearly 3 ft. long, and includes the superb stratigraphical sections of the Mount Forbes and Mons Peak region, where Carboniferous rocks appear on the crests, succeeded downwards by Devonian, Ordovician, and Upper Cambrian strata.

DR. C. D. WALCOTT, in the Middle Cambrian Burgess Shale of British Columbia, has secured a field of remarkable palæontological richness. He remarks (Smithsonian Miscell. Coll., vol. lxvii., No. 6, 1920) that the sponges from this series comprise nearly all the siliceous sponges known to him from the Cambrian strata of America. He mentions the few other known examples described by Matthew, Bornemann, and others, and now adds several new genera and species of monactinellid, hexactinellid, octactinellid, and heteractinellid types. Chancelloria, of which the general form is preserved in spite of the absence of a strong spicular skeleton, upholds Hinde's Heteractinellida as a distinct sub-order. The form of the spicules, with four to seven horizontal rays and one vertical axial ray, is not tetractinellid, while their grouping is not that of the hexactinellid mesh. The previously known imperfect specimens of this sub-order are of Carboniferous age. The spicules in the Burgess Shale are usually preserved as pyrite, like those of the British Protospongia, the glories of which are now much diminished by its rivals.

TEMPERATURES and humidities in the upper-air conditions favourable for thunderstorm development and temperatures over land and sea have been discussed by Capt. C. K. M. Douglas. The results are published as Professional Notes No. 8 by the Meteorological Office. The flight observations were made in the north of France during 1918 in the preparation of reports and forecasts for military purposes. The most marked feature of the observations was the number of instances of an unstable condition above 8000 ft. Every thunderstorm is said to have been associated with a shallow depression or secondary, and many with the arrival of cooler surface-air. Up to a level of 10,000 ft., and possibly above, the higher the humidity the greater the chance of thunderstorms, which are not likely to develop unless there is at least one fairly damp layer as low as 6000 ft. Thunderstorms in our latitudes are not usually severe if the base of the thunder-clouds is above 8000 ft.; the cloud-base is stated to be, as a rule, at about 5000 ft. or 6000 ft. in hot weather, and lower in cool weather. The height of thunder-clouds is said to be very great, the rounded tops attaining 20,000 ft. and the false cirrus 30,000 ft. in hot weather, and 15,000 ft. and 20,000 ft. respectively in cool weather. Thunderstorms are divided into three classes: (A) those due mainly to heated surface-air in fine, sunny weather; (B) those associated with powerful upper currents from south-west, the surface-wind being light and variable or southeasterly; and (C) those associated with very low upper-air temperatures in the south-westerly or north-westerly currents of cyclonic depressions. Detailed observations and weather-maps are given of each class. The whole discussion is full of valuable suggestions which will aid alike the weather forecaster and the aeronaut.

IN the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* (May–June, 1920) will be found the second part of the experimental study of the quenching of carbon steels by MM. Portevin and Garvin. This study is mainly concerned with the conditions of formation of troostite and martensite. By means of cooling curves the authors claim to have established that the formation of troostite corresponds to a rapid transformation at about 650° C., while that of martensite is due to a relatively slow transformation at a temperature which is generally below about 300° C. The former is rendered evident by a clear break in the curve, the latter merely by a gradual change in direction. It was found possible by choosing a certain rate of cooling to prepare specimens in which both these changes occurred and where the curves showed both types of change. The authors confirm the generally held view that troostite represents the chemically stable mixture of iron carbide and α-iron in a fine state of division, but their results do not throw any fresh light on the constitution of martensite.

A VERY convenient new showroom is being opened by the Cambridge and Paul Instrument Co., Ltd., at the commodious head office into which the firm has just moved at 45 Grosvenor Place, S.W.1. As a nucleus of the fine assemblage of scientific apparatus which is being brought together there, the collection of instruments shown by the company at the Engineering Exhibition at Olympia has been provided with a permanent home. This relates more particularly to industrial apparatus, and one of the most interesting items is the firm's new CO_2 recorder, which is entirely electrical in its principle. It depends for its action on resistance measurements revealing the difference in the rates of cooling of two platinum helices, one exposed to air saturated with water-vapour, and the other to the flue-gases to be tested. The indicating instrument is arranged so as to read direct in percentage of CO_2, and can be at a considerable distance from the gas-chambers. Continuously recording apparatus can be used, or one indicator can be arranged to be plugged on to any one of a number of CO_2 meters. A variety of patterns of both resistance and thermo-electric thermometers and pyrometers are included in the collection, as well as temperature measuring apparatus on other principles, pressure-gauges, measuring microscopes, fuel calorimeters, and electrical testing apparatus.

AN interesting report of tests on a 1500-kilowatt Ljungström steam turbine conducted by Capt. H. Riall Sankey appears in *Engineering* for September 10. The turbine had been in regular service for fifteen months at the date of the test in the works of Messrs. Marshall, Sons, and Co., Ltd., Gainsborough, and was constructed by the Brush Electrical Engineering Co., Ltd., at Loughborough. No overhaul of the turbine or any special preparation was made for the trials. The principal result, corrected to the guarantee figures of 190 lb. per sq. in. stop-valve pressure, 634° F. stop-valve temperature, and 28·75 in. vacuum at the turbine exhaust, was 11·95 to 12·00 lb. of steam per kilowatt-hour, as measured at the switchboard. The result is slightly below the original guarantee, and indicates that there can have been no serious wear of the blading during the period of service of the turbine. The heat supplied per minute per kilowatt ranged from 258·0 to 257·0 thermal units, and the overall efficiency ratio varied from 68·0 to 68·4 per cent.

THE steaming trials of the armoured cruiser H.M.S. *Raleigh* have just been completed on the Clyde, and form the subject of an article in

Engineering for September 24. The cruiser was built by Messrs. William Beardmore and Co., Ltd., from designs prepared in 1915. The leading consideration was suitability for ocean work in any part of the world, so that a large radius of action was necessary. Her overall length is 605 ft., beam 65 ft., and draught 17 ft. 3 in., with a displacement of 9700 tons. The speed of 30 knots at load draught required a shaft-h.p. of 60,000; she carries 1600 tons of oil-fuel and 800 tons of coal. During construction it was decided to increase the power to 70,000 shaft-h.p. Actual trials have been carried out at powers ranging from 3000 to 71,350 shaft-h.p., and at full power a speed of 31 knots was attained. A remarkable feature of the machinery performance (geared turbines) was the fact that at 35,000 shaft-h.p. a speed of 28 knots was measured. The machinery ran remarkably well and the noise of the gearing was not obtrusive.

WE have received from the firm of Mr. Charles Baker, of High Holborn, a classified list of his second-hand scientific instruments. The catalogue is divided into twelve sections, ten of which are devoted to physical and other appliances and instruments, *e.g.* the first contains particulars of apparatus and materials for microscopic work; the third, instruments used by astronomers; and the tenth is devoted to photographic apparatus. Section xi. contains a list of second-hand scientific works, including a number of bound volumes of periodicals which are for sale; while section xii. is a list of instruments which the firm is desirous of purchasing.

SIR J. A. EWING and Sir Joseph Larmor are editing, for publication by the Cambridge University Press in the spring of next year, the scientific papers of the late Prof. Bertram Hopkinson, of whom the volume will contain a memoir. The Cambridge University Press promise for the end of the present year "The Origin of Man and of His Superstitions," by Carveth Read. Portions of the work have appeared in the *British Journal of Psychology*, but they have been extended and largely rewritten for this first appearance in book form.

THE UNIVERSITY OF LONDON PRESS, LTD., announce a book by Dr. E. E. Slosson entitled "Creative Chemistry," the aim of which is to show how indigo and other coal-tar colours are made, and to arouse the interest of its readers in the practical application of modern science and so induce them to give further attention to the subject. Another book to be issued by the same publishers is "The Psychology of the Six Great Periods of Human Life," by Benchara Branford. It will be published in The New Humanist Series.

MR. F. EDWARDS, 83 High Street, Marylebone, has just circulated a finely illustrated Catalogue (No. 405) of Rare and Beautiful Books which is worthy of perusal. Among the six hundred odd works offered for sale we notice a first edition of Gerarde's "Herball," two black-letter editions of Hakluyt's "Principal Navigations, etc.," and a number of scarce gardening books.

Our Astronomical Column.

EPHEMERIS OF PALLAS.—Now that the Nautical Almanac no longer gives the places of the four bright asteroids, an ephemeris of Pallas may be of use. It is from Marseilles Circular No. 389, and is for Greenwich midnight. Perturbations were not allowed for, but the places are corrected approximately by observations during August. Opposition takes place on October 25, when the magnitude is 7·8, but the beginning of October is more favourable for observation owing to the rapid motion southward.

	R.A. h. m. s.	S. Decl. ° ′		R.A. h. m. s.	S. Decl. ° ′
Sept. 29	2 16 24	13 51	Oct. 19	2 3 18	19 33
Oct. 9	2 10 42	16 49	29	1 55 18	21 45

TEMPEL'S PERIODIC COMET.—The Japanese *Astronomical Herald* for June confirms the conjecture that the R.A. of the above comet when detected by Mr. Kudara on May 25 was 22h. 55m. 7s., not 20h. as telegraphed. This is implied in its statement that the time of perihelion passage deduced from the observation was 1920 June 10. It is seldom that an error in a single digit of a message has such serious consequences, which were the loss of two months' observation of the comet in Europe and America. Many observers searched for it, but the error of 30° in the place prevented them from finding it.

ECLIPSE OBSERVATIONS AT MONTE VIDEO.—The National Meteorological Institute of Uruguay has published an attractive volume, illustrated with numerous photographs, dealing with the observations made during the eclipses of December 3, 1918, and May 29, 1919, which were respectively annular and partial there. The co-ordinates of the Central Observatory are 3h. 44m. 51s. W. Greenwich, 34° 54′ 33″ S. The observed contacts, and comparison with those calculated from "Conn. des Temps" data, are as follows:

G.M.T. d. h. m. s.	Phase	Earlier than calculated time s.	Notes
Dec. 3 1 27 3·07	First contact	11·58	
3 12 24·34	Second ,,	16·78	
3 15 29·95	Third ,,	40·33	Uncertain, very cloudy
May 28 22 57 8·21	First ,,	10·00	
29 0 38 30·05	Second ,,	8·05	

On December 3 clouds prevented observation of Baily's Beads, stars, shadow-bands, etc. The thermometer fell from 20·4° C. before first contact to a minimum of 17·9° C. twenty minutes after mid-eclipse. The other meteorological and magnetic data are carefully recorded, but show no obvious variation due to the eclipses. But on each occasion there was a very distinct improvement in the clearness with which wireless signals from distant stations were received during eclipse—a phenomenon which has been abundantly verified elsewhere.

On December 3 an interesting record of the variation in the general illumination was obtained by exposing slips of sensitised paper to the sky for 1½ minutes at uniform intervals. The result shows a fairly smooth curve, the irregularities being due to clouds. In view of the fact that there will be an annular eclipse of the sun in Scotland next April, many useful hints for observation of the accompanying phenomena may be derived from this volume.

Fossils and Life.*

By F. A. BATHER, M.A., D.Sc., F.R.S.

I PROPOSE to consider the relations of palæontology to the other natural sciences, especially the biological; to discuss its particular contribution to biological thought; and to inquire whether its facts justify certain hypotheses frequently put forward in its name. If I subject those attractive speculations to cold analysis, it is from no want of admiration, or even sympathy, for in younger days I too have sported with Vitalism in the shade and been caught in the tangles of Transcendental hair.

The Differentia of Palaeontology.

Palæontology is often regarded as nothing more than the botany and zoology of the past. True, the general absence of any soft tissues and the obscured or fragmentary condition of those harder parts which alone are preserved make the studies of the palæontologist more difficult, and drive him to special methods. But the result is less complete; in short, an inferior and unattractive branch of biology. Let us relegate it to Section C!

Certainly the relation of palæontology to geology is obvious. It is a part of that general history of the earth which is geology. To the scientific interpreter of earth-history the importance of fossils lies, first, in their value as date-markers, and, secondly, in the light which they cast on barriers and currents, on seasonal and climatic variation. Conversely, the history of life has itself been influenced by geologic change. But all this is just as true of the present inhabitants of the globe as it is of their predecessors. It does not give the *differentia* of palæontology.

That which above all distinguishes palæontology, the study of ancient creatures, from neontology, the study of creatures now living, that which raises it above the mere description of extinct assemblages of life-forms, is the concept of Time. The bearing of this obvious statement will appear from one or two simple illustrations.

Effect of the Time-concept on Principles of Classification.

Adopting the well-tried metaphor, let us imagine the tree of life buried except for its topmost twigs beneath a sand-dune. The neontologist sees only the unburied twigs. He recognises certain rough groupings, and constructs a classification accordingly. From various hints he may shrewdly infer that some twigs come from one branch, some from another, but the relations of the branches to the main stem are matters of speculation, and when branches have become so interlaced that their twigs have long been subjected to the same external influences he will probably be led to incorrect conclusions. The palæontologist then comes, shovels away the sand, and by degrees exposes the true relations of branches and twigs. His work is not yet accomplished, and probably he never will reveal the root and lower part of the tree, but already he has corrected many natural, if not inevitable, errors of the neontologist.

* * *

Effect of the Time-concept on Ideas of Relationship.

Etienne Geoffroy-Saint Hilaire was the first to compare the embryonic stages of certain animals with the adult stages of animals considered inferior. The idea grew until it was crystallised by the poetic imagination of Haeckel in his fundamental law of the reproduction of life, namely, that every creature tends in the course of its individual development to pass through stages similar to those passed through in the history of its race. This principle is of value if applied with the necessary safeguards. If it was ever brought into disrepute, it was owing to the reckless enthusiasm of some embryologists who unwarrantably extended the statement to all shapes and structures observed in the developing animal, such as those evoked by special conditions of larval existence, sometimes forgetting that every conceivable ancestor must at least have been capable of earning its own livelihood. Or, again, they compared the early stages of an individual with the adult structure of its contemporaries instead of with that of its predecessors in time.

Such errors were beautifully illustrated in those phylogenetic trees which, in the 'eighties, every dissector of a new or striking animal thought it his duty to plant at the end of his paper. The trees have withered because they were not rooted in the past.

A similar mistake was made by the palæontologist who, happening on a new fossil, blazoned it forth as a link between groups previously unconnected—and in too many cases unconnected still. This action, natural and even justifiable under the old purely descriptive system, became fallacious when descent was taken as the basis.

The so-called "generalised types," combining the features of two or three classes, and the "annectant types," supposed to unite lines of descent which had diverged many ages before, are conceptions still with us. But they are hopelessly inconsistent with any genealogy either proved or probable.

As bold suggestions calling for subsequent proof these speculations had their value, and they may be forgiven in the neontologist, if not in the palæontologist, if we regard them as erratic pioneer tracks blazed through a tangled forest. As our acquaintance with fossils enlarged, the general direction became clearer and certain paths were seen to be impossible. In 1881, addressing this Association at York, Huxley could say: "Fifty years hence, whoever undertakes to record the progress of palæontology will note the present time as the epoch in which the law of succession of the forms of the higher animals was determined by the observation of palæontological facts. He will point out that, just as Steno and as Cuvier were enabled from their knowledge of the empirical laws of co-existence of the parts of animals to conclude from a part to a whole, so the knowledge of the law of succession of forms empowered their successors to conclude, from one or two terms of such a succession, to the whole series, and thus to divine the existence of forms of life, of which, perhaps, no trace remains, at epochs of inconceivable remoteness in the past."

Descent not a Corollary of Succession.

Note that Huxley spoke of succession, not of descent. Succession undoubtedly was recognised, but the relation between the terms of the succession was little understood, and there was no proof of descent. Let us suppose all written records to be swept away and an attempt made to reconstruct English history from coins. We could set out our monarchs in true order, and we might suspect that the throne was hereditary; but if on that assumption we were to

* Opening address of the President of Section C (Geology), delivered at the Cardiff Meeting of the British Association on August 24. Greatly abridged. Only the larger excisions are indicated by asterisks.

make James I. the son of Elizabeth—— Well, but that's just what palæontologists are constantly doing. The famous diagram of the evolution of the horse which Huxley used has had to be corrected in the light of fuller evidence. Palæotherium, which Huxley regarded as a direct ancestor of the horse, is now held to be only a collateral, as the last of the Tudors were collateral ancestors of the Stuarts. The later Anchitherium must be eliminated from the true line as a side-branch—a Young Pretender. Sometimes an apparent succession is due to immigration of a distant relative from some other region—"the glorious House of Hanover and Protestant Succession." It was, you will remember, by such migrations that Cuvier explained the renewal of life when a previous fauna had become extinct. He admitted succession, but not descent. If he rejected special creation, he did not accept evolution.

Descent, then, is not a corollary of succession; or, to broaden the statement, history is not the same as evolution. History is a succession of events. Evolution means that each event has sprung from the preceding one. Not that the preceding event was the active cause of its successor, but that it was a necessary condition of it. For the evolutionary biologist a species contains in itself and its environment the possibility of producing its successor. The words "its environment" are necessary, because a living organism cannot be conceived apart from its environment. They are important because they exclude from the idea of organic evolution the hypothesis that all subsequent forms were implicit in the primordial protoplast alone, and were manifested either through a series of degradations, as when thorium by successive disintegrations transmutes itself to lead, or through fresh developments due to the successive loss of inhibiting factors. I say "a species contains the possibility" rather than "the potentiality," because we cannot start by assuming any kind of innate power.

Huxley, then, forty years ago, claimed that palæontologists had proved an orderly succession. To-day we claim to have proved evolution by descent. But how do we prove it? The neontologist, for all his experimental breeding, has scarcely demonstrated the transmutation of a species. The palæontologist cannot assist at even a single birth. The evidence remains circumstantial.

Recapitulation as Proof of Descent.

Circumstantial evidence is convincing only if inexplicable on any other admissible theory. Such evidence is, I believe, afforded by palæontological instances of Haeckel's law, *i.e.* the recapitulation by an individual during its growth of stages attained by adults in the previous history of the race. You all know how this has been applied to the Ammonites; but any creature with a shell or skeleton that grows by successive additions and retains the earlier stages unaltered can be studied by this method. If we take a chronological series of apparently related species or mutations, a^1, a^2, a^3, a^4, and if in a^4 we find that the growth-stage immediately preceding the adult resembles the adult a^3, and that the next preceding stage resembles a^2, and so on; if this applies *mutatis mutandis* to the other species of the series; and if, further, the old age of each species foreshadows the adult character of its successor, then we are entitled to infer that the relation between the species is one of descent. Mistakes are liable to occur for various reasons, which we are learning to guard against. For example, the perennial desire of youth to attain a semblance of maturity leads often to the omission of some steps in the orderly process. But this and other eccentricities affect the earlier rather than the later stages, so that it is always possible to identify the immediate ancestor, if it can be found. An admirable example of the successful search for a father is provided by R. G. Carruthers in his paper on the evolution of *Zaphrentis delanouei*. Surely when we get a clear case of this kind we are entitled to use the word "proof," and to say that we have not merely observed the succession, but have proved the filiation.

* * *

The "Line-upon-Line" Method of Palaeontology.

You will have observed that the precise methods of the modern palæontologist, on which this proof is based, are very different from the slap-dash conclusions of forty years ago. The discovery of Archæopteryx, for instance, was thought to prove the evolution of birds from reptiles. No doubt it rendered that conclusion extremely probable, especially if the major premise—that evolution *was* the method of Nature—were assumed. But the fact of evolution is precisely what men were then trying to prove. These jumpings from class to class or from era to era by aid of a few isolated stepping-stones were what Bacon calls anticipations, "hasty and premature," but "very effective, because as they are collected from a few instances, and mostly from those which are of familiar occurrence, they immediately dazzle the intellect and fill the imagination" ("Novum Organon," i., 28). No secure step was taken until the modern palæontologist began to affiliate mutation with mutation and species with species, working his way back, literally inch by inch, through a single small group of strata. Only thus could he base on the laboriously collected facts a single true interpretation; and to those who preferred the broad path of generality his interpretations seemed, as Bacon says they always "must seem, harsh and discordant—almost like mysteries of faith."

I have long believed that the only safe mode of advance in palæontology is that which Bacon counselled, namely, "uniformly and step by step." Was this not, indeed, the principle that guided Linnæus himself? Not until we have linked species into lineages can we group them into genera; not until we have unravelled the strands by which genus is connected with genus can we draw the limits of families; nor until that has been accomplished can we see how the lines of descent diverge or converge, so as to warrant the establishment of orders. Thus by degrees we reject the old slippery stepping-stones that so often toppled us into the stream, and foot by foot we build a secure bridge over the waters of ignorance.

The work is slow, for the material is not always to hand, but as we build we learn fresh principles and test our current hypotheses. To some of these I would now direct your attention.

Continuity in Development.

Let us look first at this question of continuity. Does an evolving line change by discontinuous steps (saltations), as when a man mounts a ladder; or does it change continuously, as when a wheel rolls uphill? The mere question of fact is extraordinarily difficult to determine. Considering the gaps in the geological record, one would have expected palæontologists to be the promulgators of the hypothesis of discontinuity. They are its chief opponents.

Again I must leave the facts and their interpretation, merely reminding you of such cases as the heart-urchins or Micrasters of the Chalk. Here, where we have a fairly continuous succession of many hundred feet of similar rock, we do find a slow and gradual change, such that no clean line can be drawn between one form and its successor.

Whatever may be the explanation, the facts do seem to warrant the statement that evolutionary change can be, and often is, continuous. I propose to speak of it as "transition."

* * *

The Direction of Change.

Those who attempt to classify species now living frequently find that they may be arranged in a continuous series, in which each species differs from its neighbours by a little less or a little more; they find that the series corresponds with the geographical distribution of the species; and they find sometimes that the change affects particular genera or families or orders, and not similar assemblages subjected, apparently, to the same conditions. They infer from this that the series represents a genetic relation, that each successive species is the descendant of its preceding neighbour; and in some cases this inference is warranted by the evidence of recapitulation—a fact which further indicates that the change arises by addition or subtraction at the end of the individual life-cycle. For this appearance of successive differences we may here use the brief and non-committal term "seriation."

The comparison of the seriation of living species and genera to the seriation of a succession of extinct forms as revealed by fossils was first made by Cope, who in 1866 held the zoological regions of to-day to be related to one another "as the different subdivisions of a geologic period in time." This comparison is of great importance. Had we the seriations of living forms alone, we might often be in doubt as to the meaning of the phenomenon. In the first place, we might ascribe it purely to climatic and similar environmental influence, and we should be unable to prove genetic filiation between the species. Even if descent were assumed, we should not know which end of the series was ancestral, or even whether the starting-point might not be near the middle. But when the palæontologist can show the same, or even analogous, seriation in a time-succession, he indicates to the neontologist the solution of his problem.

Restricting ourselves to series in which descent may be considered as proved or highly probable, we find then a definite seriation—not merely transition, but transition in orderly sequence such as can be represented by a graphic curve of simple form. If there are gaps in the series as known to us, we can safely predict their discovery; and we can prolong the curve backwards or forwards so as to reveal the nature of ancestors or descendants.

Orthogenesis: Determinate Variation.

The regular, straightforward character of such seriation led Eimer to coin the term "orthogenesis" for the phenomenon as a whole. If this term be taken as purely descriptive, it serves well enough to denote certain facts. But orthogenesis, in the minds of most people, connotes the idea of necessity, of determinate variation, and of predetermined course. Now, just as you may have succession without evolution, so you may have seriation without determination or predetermination. Let us be clear as to the meaning of these terms. Variation is said to be determinate or "definite" when all the offspring vary in the same direction. All the changes are of the same kind, though they may differ in degree. For instance, all may consist in some addition, as a thickening of skeletal structures, an outgrowth of spines or horns; or all may consist in some loss, as the smaller size of outer digits, the diminution of tubercles, or the disappearance of feathers. A succession of such determinate variations for several generations produces seriation; and when the seriation is in a *plus* direction it is called progressive, when in a *minus* direction retrogressive. Now, it is clear that if a single individual or generation produces offspring with, say, *plus* variations differing in degree, then the new generation will display seriation. Instances of this are well known. You may draw from them what inferences you please, but you cannot actually prove that there is progression. Breeding experiments under natural conditions for a long series of years would be required for such proof. Here again the palæontologist can point to the records of the process throughout centuries or millennia, and can show that there have been undoubted progression and retrogression. I do not mean to assert that the examples of progressive and retrogressive series found among fossils are necessarily due to the seriation of determinate variations, but the instances of determinate variation known among the creatures now living show the palæontologist a method that may have helped to produce his series. Once more the observations of neontologist and palæontologist are mutually complementary.

Predetermination.

So much for determination; now for predetermination. This is a far more difficult problem, discussed when the fallen angels

> reasoned high
> Of providence, foreknowledge, will, and fate,
> Fixed fate, free will, foreknowledge absolute,
> And found no end in wandering mazes lost,

and it is likely to be discussed so long as a reasoning mind persists. For all that, it is a problem on which many palæontologists seem to have made up their minds. They agree (perhaps unwittingly) with Aristotle that "Nature produces those things which, being continuously moved by a certain principle inherent in themselves, arrive at a certain end." In other words, a race once started on a certain course will persist in that course, no matter how conditions may change, no matter how hurtful to the individual its own changes may be, progressive or retrogressive, uphill and downhill, straight as a Roman road, it will go on to that appointed end. Nor is it only palæontologists who think thus. Prof. Duerden has recently written: "The Nägelian idea that evolutionary changes have taken place as a result of some internal vitalistic force, acting altogether independently of external influences, and proceeding along definite lines, irrespective of adaptive considerations, seems to be gaining ground at the present time among biologists."

The idea is a taking one, but is it really warranted by the facts at our disposal? We have seen, I repeat, that succession does not imply evolution, and (granting evolution) I have claimed that seriation can occur without determinate variation and without predetermination. It is easy to see this in the case of inanimate objects subjected to a controlling force. The fossil-collector who passes his material through a series of sieves, picking out first the larger shells, then the smaller, and finally the microscopic Foraminifera, induces a seriation in size by an action which may be compared to the selective action of successive environments. There is, in this case, predetermination imposed by an external mind, but there is no determinate variation. You may see in the museum at Leicester a series beginning with the *via strata* of the Roman occupants of Britain, and passing through all stages of the tramway up to the engineered modern railroad. The unity and apparent inevitability of the series conjure up the vision of a world-mind consciously working to a foreseen end.

An occasional experiment along some other line has not been enough to obscure the general trend; indeed, the speedy scrapping of such failures only emphasises the idea of a determined plan. But closer consideration shows that the course of the development was guided simply by the laws of mechanics and economics and by the history of discovery in other branches of science. That alone was the nature of the determination, and predetermination there was none. From these instances we see that selection can, indeed must, produce just that evolution along definite lines which is the supposed feature of orthogenesis.

The arguments for orthogenesis are reduced to two: first, the difficulty of accounting for the incipient stages of new structures before they achieve selective value; and, secondly, the supposed cases of non-adaptive, or even—as one may term it—counter-adaptive, growth.

The earliest discernible stage of an entirely new character in an adaptive direction is called by H. F. Osborn a "rectigradation" (1907), and the term implies that the character will proceed to develop in a definite direction. Osborn gives as instances the first folding of the enamel in the teeth of the ancestral horses and the first slight elevation on the skull of the older Titanotheres, foreshadowing the large nose-horns of those strange Tertiary mammals. He contrasts rectigradations with the changes in shape and proportion of some pre-existing structure, and calls the latter "allometrons." Further, he claims that some predetermining law or similarity of potential governs the appearance of rectigradations, because they arise independently on the same part of the skull in different lineages at different periods of geological time.

Osborn maintains, then, that rectigradations are a result of the principle of determination, but this does not seem necessary. In the first place, the precise distinction between an allometron and a rectigradation fades away on closer scrutiny. When the rudiment of a cusp or a horn changes its form, the change is an allometron; the first swelling is a rectigradation. But both of these are changes in the form of a pre-existing structure; there is no fundamental difference between a bone with an equable curve and one with a slight irregularity of surface. Why may not the original modification be due to the same cause as the succeeding ones? The development of a horn in mammalia is probably a response to some rubbing or butting action which produces changes first in the hair and epidermis. One requires stronger evidence than has yet been adduced to suppose that in this case form precedes function. As Jaekel has insisted, skeletal formation follows the changes in the softer tissues as they respond to strains and stresses. In the evolution of the Echinoid skeleton any new structures that appear, such as auricles for the attachment of jaw-muscles and notches for the reception of external gills, have at their inception all the character of rectigradations, but it can scarcely be doubted that they followed the growth of their correlated soft parts, and that these latter were already subject to natural selection. But we may go further; in vertebrates, as in Echinoderms, the bony substance is interpenetrated with living matter, which renders it directly responsive to every mechanical force, and modifies it as required by deposition or resorption, so that the skeleton tends continually to a correlation of all its parts and an adaptation to outer needs.

The fact that similar structures are developed in the same positions in different stocks at different periods of time is paralleled in probably all classes of animals; Ammonites, Brachiopods, Polyzoa, Crinoids, and Sea-urchins present familiar instances. But do we want to make any mystery of it? The words "predisposition," "predetermining law," "similarity of potential," "inhibited potentiality," and "periodicity" all tend to obscure the simple statement that like causes acting on like material produce like effects. When other causes operate the result is different. Certainly such facts afford no evidence of predetermination in the sense that the development must take place willy-nilly. Quite the contrary; they suggest that it takes place only under the influence of the necessary causes.

The resemblance of the cuttle-fish eye to that of a vertebrate has been explained by the assumption that both creatures are descended, *longo intervallo* no doubt, from a common stock, and that the flesh or the germ of that stock had the internal impulse to produce this kind of eye some day when conditions should be favourable. It is not explained why many other eyed animals, which must also have descended from this remote stock, have developed eyes of a different kind. Nevertheless, I commend this hypothesis of Prof. Bergson to the advocates of predisposition. To my mind, it only shows that a philosopher may achieve distinction by a theory of evolution without a secure knowledge of biology.

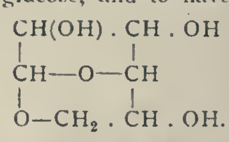
When the same stock follows two quite different paths to the same goal it is impossible to speak of a predetermined course. [An instance of this was given.]

(*To be continued.*)

The Constitution of Cellulose.

IN an illuminating lecture delivered before the French Chemical Society on May 21, Prof. A. Pictet, of Geneva, described the results obtained by his pupils and himself on distilling cellulose at a low pressure, and showed how these can be interpreted so as to throw much new light on the constitution of this complicated substance.

When cotton cellulose is heated gradually in a distilling apparatus under a pressure of 10–15 mm. decomposition begins at 210° and an oil distils over equal in weight to 45 per cent. of the original cellulose, which soon solidifies, and consists of lævoglucosan. This is considered to be an anhydride derived from β-glucose, and to have the constitution



Previous work has shown that cellulose furnishes on acetolysis a disaccharide, cellobiose, which probably contains an α-glucose and a β-glucose group. Also, with hydrobromic acid, cellulose gives bromomethylfurfurol. The origin of the latter, a hydrofuran nucleus containing two side-chains, the author terms the chitose grouping. Prof. Pictet therefore regards cellulose as containing two β-glucose groups, one chitose grouping, and probably an α-glucose group, represented thus:

β	Ch
β	α?

By acetolysis the α-glucose group and a β-glucose group together form cellobiose (50 per cent.), and in the decomposition with hydrobromic acid the chitose grouping furnishes bromomethylfurfurol (25 per cent.), the other three groups being converted into the black mass which is always formed in the reaction. Finally, on dry distillation under reduced pressure the β-glucose groupings split off to give lævoglucosan (50 per cent.), and the others, which are not volatile without decomposition, furnish water, furfurol, carbon, etc.

In the molecule of cellulose the various groups are probably united together in consequence of the opening of the ring at an oxygen atom which does not form the furan ring, and in this way the cellulose molecule, forming a vast cyclic network, may bear some analogy to those of the albuminoids, in which the linking agents are nitrogen atoms.

Joseph Black and Belfast.

UNDER the title of "Joseph Black: His Belfast Friends and Family Connections" Mr. Henry Riddell has recently published in the Proceedings of the Belfast Natural History and Philosophical Society (vol. iii., 1919–20, p. 49) an interesting account of Joseph Black's connection with Belfast. As is well known, the famous chemist was born at Bordeaux, where his father, John Black, was a factor and wine merchant, but his ancestors for many generations back were Ulstermen, and he himself received his school education either in the old Latin School in Belfast, endowed by Earl Donegall in 1666, or at the hands of a Mr. Sprott, a schoolmaster of repute in that city. Up to the age of twelve Black was educated by his mother, Margaret Gordon, who is described as a woman of great force of character and many accomplishments. She was the daughter of Robert Gordon, a merchant of Aberdeen, and was married to John Black in 1716, by whom she had issue eight sons and five daughters, Joseph Black, who was born in 1728, being the fourth son.

The Blacks were of Scottish extraction, and were said to be descended from a member of the Clan Lamont who was known as Gillie-dhu on account of his remarkably black hair. Some of his sons, on the invitation of James I., passed over to Ulster, which had been laid waste and depopulated by the wars among the Irish chiefs and their clans. Their descendants, or some of them, settled in Belfast and anglicised their name to Black. One of them, John Black, the great-grandfather of the chemist, fought as a trooper against Cromwell. His son, also John Black, born in 1682, was a burgess of Belfast, and had a family of five sons, all engaged in "merchandysinge" in various parts of the Continent. The various members married into some of the leading Ulster families—the Eccles, Wilsons, Banks, Legges, Clarkes, and others. Jane Eccles, the grandmother of the chemist, was the daughter of John Eccles of Cranmore, who entertained William III. on his way from Carrick to Drogheda. The chemist's eldest brother, John, married Jane Banks, a member of one of the best-known families in Belfast. One of their granddaughters, Maria, became the wife of Lord Downs, and from them sprang two girls, Ann and Charlotte, who married respectively Lord Clonmel and Lord Seaton. Isobel Black, the sister of the chemist, married James Burnett, of Aberdeen; their daughter became the wife of Adam Ferguson, the moral philosopher and colleague, intimate friend, and cousin of Joseph Black. A descendant of one of his other sisters, Katherine, became the wife of Prince Waldeck and Pyrmont.

Two of Joseph's brothers, Samuel and George, returned to Belfast and took a prominent part in the municipal life of the town, holding the office of "Sovereign" (mayor) between them no fewer than seven times between 1772 and 1789.

Joseph Black, after a good grounding in classics and mathematics, left Belfast for Glasgow in his eighteenth year, entering the University, therefore, considerably older than the usual run of matriculants at that period. He came almost immediately under the influence of two remarkable men, Dick, professor of natural philosophy, and Cullen, professor of medicine and lecturer on chemistry. The fact that Black was considerably senior to the majority of his fellow-students may have induced Cullen to offer him the position of lecture-assistant, and it was probably this fortunate circumstance that determined his career.

The great chemist, who died in 1799, was never married, and left no immediate descendants. It is evident from this short statement that he belonged to a family of noteworthy mental peculiarities, many members of which were characterised by remarkable powers and capacity. Joseph Black, so far as is known, is the only one who showed any striking predilection towards scientific pursuits, and there are special circumstances in his case which may serve to explain the direction of his inclinations. If, as the late Sir Francis Galton contended, high reputation is a pretty accurate test of high ability, Joseph Black certainly ennobled his ancestry. But an examination of their individual history seems to show that he is no less a debtor to those who went before him, and that his eminence is in no small degree due to qualities implanted in him by his Ulster upbringing and associations.

T. E. THORPE.

The Sakura-jima Eruption of 1914.

PROF. OMORI has recently made two additions to his valuable series of memoirs on the eruption of the Sakura-jima (South Japan) on January 12, 1914. The fourth memoir deals with the continued changes of elevation in the neighbourhood of the volcano, and the fifth with the numerous earthquakes which preceded and followed the eruption (Bull. Imp. Earthq. Inves. Com., vol. viii., 1920, pp. 323–51 and 353–466). Until 1914 the Sakura-jima was an island in the Bay of Kagoshima, the inner bay to the north of it being a basin 12½ miles long from east to west and 7½ miles wide. A comparison of two series of levels made a few years before the eruption and in April and May, 1915, revealed a depression of not less than 20 in. in the northern part of the bay, and of from 1 ft. to 5½ ft. round the coast of the former island, the centre of which was elevated in two places by as much as 30 ft. and 41 ft. In the winter of 1918–19 a new series of levels was made along the west and north coasts of the bay, from which it is seen that the depression of the inner bay gave place to an elevation, the mean rise from February, 1915, to December, 1918, being about 4 in. In 1917 a series of soundings was also made in the bay, and these show that there are three depressions (of maximum depth 85, 113, and 79 fathoms), the first being separated from the others by a submarine ridge running north from the volcano, and apparently due to the eruptions of A.D. 764, 1468–76, and 1779. Comparing the new soundings with those made in 1906, there are seen to be three areas of fresh depression (from 3 to 4 fathoms) coinciding with the three depressions, and two areas of new elevation, the more important one (of 3 fathoms) being near the submarine ridge. Prof. Omori estimates that the total resultant depression of the district amounts to about one-quarter of a cubic mile, and the volume of lava and ashes ejected to slightly more than one-half of a cubic mile, and he suggests that this difference may account for the defect of gravity sometimes observed in the neighbourhood of a volcano.

The records of the Sakura-jima earthquakes at Kagoshima (6½ miles from the volcano), Nagasaki

(92 miles), and Osaka (348 miles) leads to the following conclusions:—(1) The frequent occurrence of earthquakes, both unfelt and strong, terminated at or immediately before the opening of the eruption; (2) the principal centre of the after-shocks coincides roughly with the centre of elevation of the sea-bed to the north of the Sakura-jima, which is 8·9 miles from Kagoshima; (3) the mean duration of the preliminary tremor at this place was 1·94 seconds, corresponding to a focal distance of 8·9 miles, from which it follows that the focal depth was very small; and (4) in the after-shocks the first distinct displacement was usually directed towards or from the source of disturbance, while the mean directions of the maximum vibrations were parallel and perpendicular to the line joining the craterlets on the two flanks of the volcano. C. D.

University and Educational Intelligence.

AN introductory public lecture to a series of seven courses of lectures on the history of science will be given by Sir W. H. Bragg at University College (University of London) on Thursday, October 7, at 5 p.m. The courses arranged are as follows:—The General History and Development of Science, Dr. A. Wolf; The More Important Developments in Physical Science during the Nineteenth Century, Sir W. H. Bragg, Prof. E. J. Garwood, Mr. D. Orson Wood, and others; Egyptian Science, Prof. Flinders Petrie; The History of the Biological and Medical Sciences from Early Times to the Eighteenth Century, Dr. Charles Singer; The History of the Biological Sciences since the Eighteenth Century, Prof. J. P. Hill; Elementary Astronomy, treated Historically, Prof. L. N. G. Filon; and The History of Mathematics up to the Eighteenth Century, Mr. T. L. Wren.

IN the annual report for 1919–20 of the Coventry Public Libraries several points are worthy of notice. Figures are given showing the number of issues which have been made during the past and the previous year. Of the total of 380,170 issues of books in 1919–20, 167,758 were of technical and literary books, while 144,296 were works of fiction. The figures are significant of the use to which the library is put by the inhabitants. As compared with the previous year, the number of issues of technical works has increased by 26,976, while the increase for fiction was only 2087. These figures indicate the revival of study which was to be expected with the return of students to peaceful occupations. In the issues of the home-reading libraries similar figures were observed, the increase in the demand for works on the arts and sciences being 6449. On the other hand, research work, by which is meant the study of the accumulated data of a subject before proceeding with investigations, has declined since the armistice. Only one-twelfth of the 82,245 volumes in stock are classed as fiction. The libraries are intended chiefly for the use of students, and their continued popularity shows that they are appreciated as such.

THE President of the Board of Education has addressed a letter to the Vice-Chancellor of the University of London (Dr. Russell Wells), under date September 24, with reference to the Government offer of a site for the University behind the British Museum, explaining that, with the consent of the vendor (the Duke of Bedford), it is possible for the offer to remain open until the Senate's meeting on October 20, but no longer. Mr. Fisher expresses general approval of the proposed conditions to be attached to acceptance of the offer which were discussed by the Senate in July, save that respecting freedom from debt as regards the new buildings before the old buildings are vacated. He suggests a revision of the wording of this condition, but admits that the Government fully shares the view as to the undesirability of the University and King's College entering upon the occupation of their new buildings under an embarrassing load of debt. Mr. Fisher further explains that the Government offer is not available for any alternative site, since on a review of all the circumstances the Government has come to the definite conclusion "that the site behind the British Museum is the most suitable and the only one which they would feel justified in acquiring for offer to the University." In conclusion, Mr. Fisher expresses his earnest hope that the Senate will decide to accept the offer which the Government has made.

THE educational system of Japan (Bulletin No. 57, 1919, of the United States Bureau of Education) is the result of a fusion of the traditional training in national humanistic studies with that in modern science. Progress is possible on the latter side only. Technical education of an elementary type is given in the vocational schools, to which students who have passed through the elementary schools are admitted. In 1915–16 the number of technical schools attached to such vocational institutes was 9001, an increase of 533 over the preceding year; while that of the private technical schools was 366, an increase of 20. Approximately 95,000 pupils were enrolled in all schools of this kind, exclusive of continuation schools. The technical continuation schools admit students who have passed the standard of the elementary schools, though the individual school authorities have power to admit or refuse any candidate. In the year 1915–16 407,600 male pupils and 89,601 females were enrolled in these schools, an increase of nearly 50,000 over the numbers joining during the previous year. Within the next six years it is proposed to spend some four and a half million pounds on higher education. The technical and high schools already in existence will accommodate 14,000 students only, while during the year 1917–18 about 56,000 applied for admission. This money will therefore be devoted to the building of ten new high schools and eighteen new technical and commercial institutes. Great prominence is given to the rapid but efficient training of teachers of all grades.

Societies and Academies.

PARIS.

Academy of Sciences, August 30.—M. Henri Deslandres in the chair.—G. **Humbert**: An arithmetical link between the real ternary quadratic forms and the indefinite forms of Hermite.—H. **Deslandres**: The recognition in stars of the successive layers of their atmosphere and the periodic variations of these stars. From the study of the calcium lines in the solar spectrum the existence of three layers in the solar atmosphere has been deduced. The same method can be applied to the fixed stars, and an account is given of the results obtained up to the present by various observers.—E. **Ariès**: The specific heat of saturated vapours at low temperatures. Reply to a communication by G. Bruhat.—J. **Andrade**: The regulating organs of chronometers.—E. **Jouguet**: Waves of shock in solid bodies.—M. **Galbrun**: The deformation of a helical spring.—M. **d'Azambuja**: The spectrum of the new star in Cygnus. On August 25 and 28 the spectrum of the new star presented the appearance usual with novæ in the course of the first stage of their evolution.—M. **Burson**: The spectrum of Nova Cygni.

—C. **Raveau**: The thermodynamical properties of fluids in the neighbourhood of the critical state.—MM. **Orékboff** and **Tiffeneau**: The hydrobenzoin transposition. The influence of the paramethoxy-substitution on the dehydration of the triarylglycols.—G. **Zeil**: The ascending movements of the earth's crust and the recurrences of subterranean erosion.—E. **Aubel**: The influence of the nature of the carbon compounds present on the utilisation of nitrogen by *Bacillus subtilis*.

September 6.—M. Léon Guignard in the chair.—A. **Lacroix**: The regular grouping of two different minerals constituting certain ores of iron and titanium.—M. **Laubeuf**: A small submarine for oceanogcaphic work. Details of design and equipment of a small submarine, 18·8 metres in length and of 50 tons displacement, for use in oceanography. It would sustain the pressure of water at depths of 80 to 100 metres, and, it is estimated, would now cost 600,000 francs to build, although in 1907, when the plans were first drawn up, it could have been built for less than a third of that sum. The work suggested for this submarine includes collecting samples from the ocean-floor, water at various depths, plankton, and observations on temperature and transparency of water and the direction and velocity of the currents.—P. **Humbert**: Hypercylindrical functions.—C. **Nordmann**: Observations of the new star in Cygnus, made at the Paris Observatory with a heterochrome photometer. In this apparatus the ratio of the intensities of the star studied and a known star is compared in various regions of the spectrum by equalising by means of Nicol prisms the brightness of the star under examination and that of an artificial star observed simultaneously through a coloured screen. It was found that the magnitude of the new star changed from 3·43 on August 27 to 4·01 on August 29. The brightness of the new star is, therefore, rapidly decreasing. On the first date the star had an effective temperature of 6100° C., which on the later date had increased to 7800°. Attention is directed to the fact that the increase of effective temperature is accompanied by a diminution in the brightness, contrary to what would have been expected.—H. **Groullier**: First observations of Denning's nova made at the Lyons Observatory. Measurements of the magnitude of the star on August 23, 24, 25, 26, and 27. The brightness passed through a maximum on August 24 and then rapidly decreased.—J. **Guillaume**: Observations of the sun made at the Lyons Observatory during the first quarter of 1920. Observations were possible on sixty-eight days, and the results are summarised in three tables showing the number of sunspots, their distribution in latitude, and the distribution of the faculæ in latitude.—J. **Rouch**: Inversions of temperature in the lower atmospheric layers in the Antarctic.

WASHINGTON, D.C.

National Academy of Sciences (Proceedings, vol. vi., No. 3, March).—S. **Flexner**: Encephalitis and poliomyelitis. A short sketch of the present state of knowledge relative to these two diseases.—A. F. **Kovarik**: A statistical method for studying the radiations from radio-active substances and the X-rays, and its application to some X-ray problems. A continuation of the work of Kovarik and McKeehan. The author finds 7×10^{10} γ-rays from radium B and C per second per gram of sodium instead of 3×10^{10} formed by Lawson and Hess.—L. B. **Loeb**: The nature of the heat production in a system of platinum black, alcohol, and air. Of the two theories that the heat is due (1) to the adsorption of alcohol and (2) to the oxidation of the alcohol at the platinum surface, the latter is substantiated.—H. **Noguchi**: *Leptospira icteroides* and yellow fever. A special organism, *Leptospira icteroides*, has been detected in certain cases of yellow fever. Guinea-pigs have been inoculated with it by Stegomyias, but until further studies have been made its standing as the inciting agent of yellow fever cannot be regarded as certain.—S. **Hecht**: Human retinal adaptation. A binocular reaction is involved; in all essentials the mechanism underlying the initial phase of retinal sensitivity in dim light is the same as involved in the initial process of photoreception in Mya and Ciona.—L. **Page**: A kinematical interpretation of electromagnetism. The equations of electrodynamics are shown to be simple kinematical relations between the moving elements which constitute lines of force.—A. A. **Michelson**: The laws of elastico-viscous flow, ii. A criticism of the formula which combines the laws of Larmor and Maxwell; an elaboration with many data of a previous paper of the same title.—H. **Shapley**: A note on a simple device for increasing the photographic power of large telescopes. A short-focus lens is placed in the converging beam at an appropriate distance in front of the photographic plate, giving high speed and reducing the scale on the photograph.—L. R. **Sullivan**: Anthropometry of the Siouan tribes. Of interest (1) because accurately describing and defining the Siouan type and showing its relationship to American Indian tribes already described, and (2) because of the intermixture of two widely separated races represented by this series of individuals.—F. M. **Guyer** and E. A. **Smith**: Transmission of eye-defects induced in rabbits by means of lens-sensitised fowl-serum. The defects have been transmitted to the sixth generation.—H. G. **Barbour** and J. B. **Hermann**: The mechanism of fever reduction by drugs. Antipyritic drugs increase the blood-content of dextrose. In fevered animals this is accompanied by dilution of the blood, with resulting fall in temperature.—E. H. **Hall**: Inferences from the hypothesis of dual electric conduction: The Thomson effect. A tabulation of a great variety of data correlated with theory under either of two hypotheses of electron equilibrium in metals unequally heated.—C. L. E. **Moore** and H. B. **Phillips**: Note on geometrical products. Development of a series of geometrical products, independent of the dimensions of space, intermediate between the progressive and the inner product.

Books Received.

The Manufacture of Sugar from the Cane and Beet. By T. H. P. Heriot. (Monographs on Industrial Chemistry.) Pp. x+426. (London: Longmans, Green, and Co.) 24s. net.

Children's Dreams. By Dr. C. W. Kimmins. Pp. 126. (London: Longmans, Green, and Co.) 5s. net.

Margarine. By W. Clayton. (Monographs on Industrial Chemistry.) Pp. xi+187. (London: Longmans, Green, and Co.) 14s. net.

Weeds of Farm Land. By Dr. W. E. Brenchley. Pp. x+239. (London: Longmans, Green, and Co.) 12s. 6d. net.

Geologie des Meeresbodens. Band ii., Bodenbeschaffenheit, Nutzbare Materialien am Meeresboden. By Prof. K. Andrée. Pp. xx+689+7 Tafeln. (Leipzig: Gebrüder Borntraeger.) 92 marks.

Insect Adventures. By J. H. Fabre. Pp. xii+308. (London: Hodder and Stoughton, Ltd.) 8s. 6d. net.

The Psychology of Dreams. By W. S. Walsh. Pp. xi+361. (London: Kegan Paul and Co., Ltd.) 12s. 6d. net.

Among the Ibos of Nigeria. By G. T. Basden.

Pp. 315. (London: Seeley, Service, and Co., Ltd.) 25*s*. net.

Anæsthetics: Their Uses and Administration. By Dr. D. W. Buxton. Sixth edition. (London: H. K. Lewis and Co., Ltd.) 21*s*. net.

Among the Natives of the Loyalty Group. By E. Hadfield. Pp. xix+316. (London: Macmillan and Co., Ltd.) 12*s*. 6*d*. net.

Mind-Energy: Lectures and Essays. By Prof. H. Bergson. Translated by Prof. H. Wildon Carr. Pp. x+212. (London: Macmillan and Co., Ltd.) 10*s*. net.

Higher Mechanics. By Prof. H. Lamb. Pp. x+272. (Cambridge: At the University Press.) 25*s*. net.

Ministry of Finance, Egypt. Survey of Egypt. Geological Survey. Palæontological Series, No. 4. Catalogue des Invertébrés Fossiles de l'Egypte. By R. Fourtau. Terrains Tertiaires. 2de Partie: Echinodermes Néogènes. Pp. vii+100+iv+xii plates. (Cairo: Government Press.) 40 P.T.

A Practical Handbook of British Birds. Part ix., vol. ii. Pp. 80+1 plate. (London: Witherby and Co.) 4*s*. 6*d*. net.

Experiment Station of the Hawaiian Sugar Planters' Association. The Leguminous Plants of Hawaii. By Prof. J. F. Rock. Pp. x+234. (Honolulu, Hawaii.)

Die Entstehung und Bisherige Entwicklung der Quantentheorie. By Max Planck. Pp. 32. (Leipzig: J. A. Barth.) 4 marks.

The Romance of the Microscope. By C. A. Ealand. Pp. 314. (London: Seeley, Service and Co., Ltd.) 7*s*. 6*d*. net.

Animal Ingenuity of To-day. By C. A. Ealand. Pp. 313. (London: Seeley, Service and Co., Ltd.) 7*s*. 6*d*. net.

The History of Social Development. By Dr. F. Müller-Lyer. Translated by Elizabeth C. Lake and H. A. Lake. Pp. 362. (London: G. Allen and Unwin, Ltd.) 18*s*. net.

Experimental Science. By S. E. Brown. I., Physics; Section v., Light. Pp. vii+273–424. (Cambridge: At the University Press.) 6*s*. net.

The Lure of the Hive. By H. Clark. Pp. 24. (Leicester: P. Stevens.) 4*d*.

Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1919–20. (Cmd. 905.) Pp. 120. (London: H.M. Stationery Office.) 1*s*. net.

The Tomb of Antefoker, Vizier of Sesostris I., and of his Wife, Senet. By N. de Garis Davies. (Theban Tombs Series, No. 60.) Second Memoir. Pp. iii+40+48 plates. (London: G. Allen and Unwin, Ltd.) 2 guineas net.

The Foundations of Character. By A. F. Shand. Second edition. Pp. xxxvi+578. (London: Macmillan and Co., Ltd.) 20*s*. net.

The Carbohydrates and Alcohol. By Dr. S. Rideal and Associates. Pp. xv+219. (London: Baillière, Tindall and Cox.) 12*s*. 6*d*. net.

A Treatise on Chemistry. By Sir H. E. Roscoe and C. Schorlemmer. Vol. i., The Non-Metallic Elements. Fifth edition, completely revised by Dr. J. C. Cain. Pp. xv+968. (London: Macmillan and Co., Ltd.) 30*s*. net.

The Atlas Geographies: Preparatory. Scotland. By T. S. Muir. Pp. 32. (Edinburgh: W. and A. K. Johnston, Ltd.; London: Macmillan and Co., Ltd.) 1*s*. net.

Union of South Africa. Department of Agriculture. The Seventh and Eighth Reports of the Director of Veterinary Research. Pp. v+734+7 plates. (Pretoria, P.O. Box 593: Director of Veterinary Research.) 10*s*.

Forestry Commission. Bulletin No. 2, Survey of Forest Insect Conditions in the British Isles, 1919. Pp. 35+3 plates. (London: H.M. Stationery Office.) 1*s*. 6*d*. net.

Forestry Commission. Bulletin No. 3, Rate of Growth of Conifers in the British Isles. Pp. 86. (London: H.M. Stationery Office.) 3*s*. net.

Field Observations on British Birds. By A Sportsman Naturalist. Edited by H. Balfour. Pp. xvi+229+vi plates. (London: Selwyn and Blount.) 25*s*. net.

Warfare in the Human Body. By Morley Roberts. Pp. xiii+286. (London: Eveleigh Nash Co., Ltd.) 18*s*. net.

Diary of Societies.

THURSDAY, OCTOBER 7.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Maj.-Genl. Sir F. H. Sykes: Civil Aviation.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. C. W. Kimmins: The Handwriting of the Future.

MONDAY, OCTOBER 11.

BIOCHEMICAL SOCIETY (at King's College).

WEDNESDAY, OCTOBER 13.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 8.—Sir Henry Fowler: Presidential Address.

THURSDAY, OCTOBER 14.

INSTITUTION OF AUTOMOBILE ENGINEERS (at 28 Victoria Street), at 8.—Graduates Meeting. Messrs. Chatterton and Watson: Factors affecting Power Output.

FRIDAY, OCTOBER 15.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Keith: Demonstration on the Contents of the Museum.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—T. M. Ainscough: British Trade with India.

SATURDAY, OCTOBER 16.

PHYSIOLOGICAL SOCIETY (at Guy's Hospital).

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NATURE

THURSDAY, OCTOBER 7, 1920.

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The Metric System and International Trade.

IN the year 1917, when the nation was in the throes of war, a committee of the Conjoint Board of Scientific Societies arrived at certain conclusions on the question of the compulsory adoption of the metric system in Great Britain, but, unfortunately for the committee, the publication of its findings has been delayed until the present time.[1] During the intervening three years our attention has been transferred from warlike to peaceful occupations, and the nation at large is now much more alive to the necessity of improving our commercial equipment for the impending vital struggle to recover and expand our overseas trade in order that we may "pay for the war." The committee apparently appreciates this change in the general atmosphere, and has accordingly published an apologetic prefatory note, from which it incidentally appears that the chief source of its evidence was the "Report on Commercial and Industrial Policy after the War." It may be recalled that Lord Balfour of Burleigh, the chairman of that committee, naïvely admitted afterwards, during a House of Lords debate on decimal coinage, that his committee had been so overloaded with other problems that the subject of decimalisation had possibly not received the attention it really deserved.

Unfortunately, this preface will probably escape general attention, because so many readers will skip it, glance through the report, and really note only the final "Recommendations," which are published on p. 35 of the committee's report, and are about as unsatisfactory as they could well be. Hence we have the lay Press to-day stating that British men of science have denounced the metric system, whereas actually the report has not been adopted by the Conjoint Board, and is issued solely on the authority of the committee. Moreover, in par. 88 of the report the committee recognises "the intrinsic superiority of the metric system in scientific and technical work."

One looks in vain for a note in these recommendations to the effect that the metric system is (*a*) already universally employed in science; (*b*) the practical basis of industry in many countries the trade of which we seek; (*c*) already legally recognised throughout the civilised world; and that accordingly, in the interests of the scientific permeation of industry, as well as of the expansion of our overseas trade, everything possible should be done to encourage its use. Instead of this, we find the committee recommending "that the British system of units of weights and measures be retained in general use in the United Kingdom," which is tantamount to suggesting that British manufacturers engaged in world-wide trade must continue indefinitely to employ two systems—the British for home trade and the metric for overseas trade—involving an increasing volume of misunderstandings and unnecessarily wasted time spent in conversions from one system to the other. If the British manufacturer can, as he already does, sell a portion of his output under metric description, he can obviously sell the whole of it on that basis, and he should clearly be encouraged to conduct all his business in one language of quantity instead of two.

In par. 82 of the report the following constructive sentence occurs: "In the opinion of the committee it would be to the advantage of British industry if the manufacture of all machinery and apparatus of new types were to be established as a matter of course in the metric system; and that this practice should be directed and encouraged by specification in this system for Government and official work"; and yet no reference is made to this in their final "recommendations," which, instead, include a plea for the continued use of British units by Departments of State.

[1] "Report on Compulsory Adoption of the Metric System in the United Kingdom." Submitted by the Metric Committee appointed by the Conjoint Board of Scientific Societies, and published on the authority of the Committee. Pp. 70. (London: Board of Scientific Societies, Royal Society, n.d.) Price 1*s*.

According to the second recommendation, the committee apparently views with equanimity the perpetuation of our use of two systems where one would suffice for all purposes. In the third recommendation the committee suggests the decimalisation of the British units of weight and measure, thus supporting a proposal roundly condemned by a select committee of the House of Commons which, in 1862, reported that "It would involve almost as much difficulty to create a special decimal system of our own as simply to adopt the metric system in common with other nations. And if we did so create a national system we would, in all likelihood, have to change it again in a few years, as the commerce and intercourse between nations increased, into an international one."

Our choice to-day rests between (1) the continued use of a dual system (because we must employ the metric system in an increasing proportion of our business, whether we like it or not), and (2) the establishment of the metric system as the universal language of quantity (involving the gradual abandonment of the Imperial system which, by reason of its manifest defects, is so obviously unsuitable for universal adoption).

It is sheer insularity which makes us cling to the first course and, regarding the alternative, the committee of the Conjoint Board states in par. 50 of its report (but omits from the "recommendations") that "It will be sufficient for the purpose of this inquiry to admit unreservedly that the metric system of weights and measures is the only system which has considerable claims to be truly international, and that it is the only system to which a change could reasonably be made should any country propose to abolish its existing national system."

Some further Government action is clearly required beyond the Act of 1897, but it does not necessarily follow that the next step need be the adoption of legislation of a compulsory character. The Government could do very much to *encourage* the more widespread use of the system by its employment in Government specifications and by a declaration that ultimately at some future date (not necessarily fixed at present) the metric system would become the sole legal system in this country. Many manufacturers would be thereby stimulated to establish all their new standards and their revisions of old standards in terms of the metric system, and there would be nothing to prevent them from continuing to manufacture their existing standards in the British system and describing them for sale in terms of the metric system, as they already have done for so many years. We should thus progress beyond the present passive permission, through a period of intensive encouragement, to the final stage in which the metric system would become the sole legal system of weights and measures, when "compulsion" need be applied only to the stragglers who had failed to adopt it voluntarily.

It is satisfactory to note that with regard to decimal coinage the committee "sees no serious objection in principle" to the proposals for decimalising the £ sterling, and it may be interested to know that the revision of Lord Southwark's Bill is now under consideration with a view to the removal of some of the practical difficulties to which the committee refers. In the meantime we may perhaps be permitted to remark that it is futile to talk about "preserving the credit of the penny" at a time like the present, when the failure of the penny to meet modern conditions is so very obvious.

Harry Allcock.

The Study of Live Embryos.

Contributions to Embryology. Vol. ix., Nos. 27 to 46. A Memorial to Franklin Paine Mall. (Publication No. 272.) Pp. v+554+plates. (Washington: The Carnegie Institution of Washington, 1920.)

Long before the war it was being realised in England that the centre of embryological research, at least so far as concerns inquiries into the developmental stages of the human body, was shifting from the laboratories of Germany to those of the United States. The transference was the work of one man—the late Prof. F. P. Mall, who died in 1917 at the age of fifty-five. Prof. Mall stocked the new and highly equipped anatomical laboratories of the United States with young men and women who had served their apprenticeship with him in the anatomical department of Johns Hopkins Hospital, Baltimore. In 1918 he would have reached the twenty-fifth anniversary of his appointment at Baltimore, and his pupils, "in recognition of his inspiring leadership, and in response to the strong feeling of affection with which they had come to regard him," intended to mark the occasion by dedicating to him a volume of their most recent investigations. These essays, owing to his untimely death, have now to appear as a memorial volume, and the sense of regret that Prof. Mall did not live to study it will be felt as acutely on this side of the Atlantic as on the other, for many of its contributors have made highly important additions to our knowledge of the growing embryo. The volume is issued by the Carnegie Institution of Washington, under the ægis of which Prof. Mall had established a department of embryology two years before his death.

In these essays we see employed the exact technique which Prof. Mall learned when working under the late Prof. His, of Leipzig, but in addition there is evidence of a clear realisation that embryology is a series of vital processes, and that to understand them the living as well as the dead embryo must be studied. The developing chick lends itself particularly well for vitalistic observation, but we have every reason to suppose that the earlier stages of mammalian development—including the early stages in the growth of the human ovum—can be investigated in a similar manner. In this respect a return has been made to the earlier methods of Harvey and of Hunter.

As examples of the vitalistic method of observation, we may cite papers by Prof. Florence Sabin on "The Origin of Blood-vessels and of Red Blood Corpuscles," by Dr. Eliot R. Clark and Eleanor L. Clark on "The Origin and Early Development of the Lymphatic System," and by Dr. Margaret R. Lewis on "Muscular Contraction in Tissue Cultures." Prof. Sabin shows that blood-vessels arise from islets, or groups, of angioblastic cells, which by canaliculisation and inosculation unite to form a capillary network. The angioblastic cells give rise to the endothelial lining of blood-vessels, and both the angioblasts and endothelial cells can, and do, produce nucleated red blood corpuscles. The lymphatic system of vessels, however, as one is led to infer from the experiments of the two Clarks, arises from the endothelium of the veins in certain embryonic regions, and from these regions, or centres, the endothelial outgrowths invade certain neighbouring areas of the body and thus provide it with a lymphatic system. If one centre of outgrowth is destroyed, neighbouring centres will supply the deficiency.

Another series of papers records observations on the vital reactions of certain cells in the body of adult animals. Capt. Charles Essick found that when a solution containing fine particles was placed in the sub-arachnoid spaces of the brain of a living animal the endothelial cells of these spaces were transformed into phagocytes, which consumed the foreign matter thus introduced. Capt. Essick's investigation was occasioned, apparently, by observations made by Capt. Lewis H. Weed during a research on "The Experimental Production of Hydrocephalus"—an important inquiry which also appears in this memorial volume. To this series also belongs the paper contributed by Dr. Charles C. Macklin on "The Development and Function of Macrophages in the Repair of Experimental Bone-wounds Vitally Stained with Typan-blue." We infer from Dr. Macklin's experiments that the phagocytes which appear at the sites of repair and of rapid growth have, as their chief business, the consumption of tissue-débris and the rendering of that débris fit for return to the general circulation of the body. Dr. George Corner's observations on "The Widespread Occurrence of Reticular Fibrils produced by Capillary Endothelium" serve to enhance the functional importance of the cells which line blood and lymphatic vessels.

Besides these papers on the living behaviour of the tissues of the body, this volume contains important contributions to orthodox or morphological embryology—particularly a most valuable summary of the present state of our knowledge of the youngest known human embryos, given by Prof. George L. Streeter, who succeeded Prof. Mall as director of the department of embryology in the Carnegie Institution of Washington. Dr. Warren H. Lewis's description of the skull of a human fœtus towards the end of the second month of development is also a very welcome addition to our knowledge of the human body. Other papers, like those of Prof. C. R. Bardeen on "The Post-natal Development of the Human Body," Prof. Robert Bean's on "The Post-natal Growth of the Heart, Kidneys, Liver, and Spleen of Man," and Dr. Schultz's "Development of the External Nose of Whites and Negroes," represent contributions to anthropology as well as to embryology. Altogether, this volume represents a worthy memorial to a really great man.

Two Books for the Country.

(1) *Springtime and Other Essays.* By Sir Francis Darwin. Pp. vii + 242 + viii plates. (London: John Murray, 1920.) Price 7s. 6d. net.

(2) *Memories of the Months.* Sixth series. By the Right Hon. Sir Herbert Maxwell, Bart. Pp. xi + 314. (London: Edward Arnold, 1919.) Price 7s. 6d. net.

(1) SIR FRANCIS DARWIN'S essays have a peculiar charm; the reader is caught in the current of the author's enjoyment. Uninfluenced by artifice, we find ourselves sharing in his pleasures, and, to begin with, in the delight of the spring renascence. "The spring is the happiest season for those who love plants, who delight to watch and record the advent of old friends as

the great procession of green leaves and beautiful flowers unwinds itself with a glory which no familiarity can tarnish." To a representative list in the order of their flowering, Sir Francis adds the remark: "To a lover of plants, this commonplace list will, I hope, be what a score is to a musician, and will recall to him some of the charm of the orchestra of living beauty that springtime awakens."

The book begins with "Springtime" and ends with "A Procession of Flowers," behind both essays lying the problem of "the elements in the struggle for life which fix the dates on which plants habitually flower." "It looks, to put the thing fancifully, as if a parliament of plants had met and decided that some arrangement must be made, since the world would be inconveniently full if they all flowered at once; or they may have believed that there were not enough insects to fertilise the whole flora, if all their services were needed in one glorious month of crowded life. Therefore it was ruled that the months should be portioned among the aspirants, some choosing May, others June or July. But it must have been difficult to manage, and must have needed an accurate knowledge of their own natural history." Similar touches of wise humour are not rare. "It has been said that Thoreau, the American recluse and naturalist, knew the look of the countryside so intimately that had he been miraculously transferred to an unknown time of year he would have recognised the season 'within a day or two, from the flowers at his feet.' If this is true, either American plants are much more business-like than ours (which is as it should be), or else Thoreau did not test his opinions too severely, and this seems even more probable." For, as a matter of fact, the dates of flowering vary considerably with the temperature and some other environmental variables—a fact which gives subtle value to old-fashioned phenological maxims: "When the sloe tree is as white as a sheet, You must sow your barley be it dry or wet"; "When we hears the wryneck, we very soon thinks about rining (barking) the oaks." "There is," Sir Francis says, "something delightfully picturesque in the thought of man thus helped and guided on some of his most vital operations by the proceedings of the world of plants and animals, to whom that hard taskmaster, Natural Selection, has taught so much."

Another delightful essay discusses the traditional names of English plants. "The fact that language is handed on from one generation to the next may remind us of heredity, and the way in which words change is a case of variation. But we cannot understand what determines the extinction of old words or the birth of new ones. We cannot, in fact, understand how the principle of natural selection is applicable to language: yet there must be a survival of the fittest in words, as in living creatures." The author proceeds to show how "the wonderful romance inherent in the great subject of evolution also illumines that cycle of birth and death to which existing plant-names are due."

This is scarcely the place for an appreciation of the essays on "Some Names of Characters in Fiction" or "Old Instruments of Music," or for those on Sydney Smith and Charles Dickens, but they are not less interesting than those on Sir Joseph Dalton Hooker and Sir George Biddell Airy. In connection with the last, we looked for some remark on the astronomer's paper on phyllotaxis, which seemed to us particularly luminous many years ago, but we were disappointed. Very delightful are the author's personal recollections, especially of his early years. We have not the courage to write in Nature of the way in which Francis Darwin expressed in the church at Down his innate fondness for musical instruments; but we are within safe natural history lines in quoting the next two sentences: "The only other diverting circumstance was the occurrence of book-fish [Lepisma?] in the prayer-books or among the baize cushions. I have not seen one for fifty years, and I may be wrong in believing that they were like minute sardines running on invisible wheels." One more quotation from a fascinating book, and we have done: "I continued to work with my father at Down, and in spite of the advantages I gained by seeing and sharing in the work of German laboratories, I now regret that so many months were spent away from him."

(2) Sir Herbert Maxwell has given us a sixth volume of his "Memories of the Months," and it will be as much appreciated as its predecessors. It consists, for the most part, of evening recollections of the natural history experiences of the day. The breezes play with the pages. For while the author is often erudite he never wears his learning but lightly. The year begins with winter flowers and winter visitors, with the humble leek which Nero is said to have loved, and with good-going problems like the significance of the white disc on the roe-deer's rump or the rabbit's cotton-tail. The temperature rises, and we have daffodils and birds' nests and the puzzles of the cuckoo and the corncrake. In speaking of the frog-hopper, the author slips in calling it a diminutive member of the grasshopper family, and his story of the

foam-making is not quite accurate. But this is merely a crumpled rose-leaf: Summer's memories deal with butterflies, British orchids, the behaviour of a hunter-wasp, the ways of char, and the insurgence of climbing plants. Here also is included an unashamed confession of faith in the powers of the divining rod. In the fall of the year Sir Herbert discourses on gossamer and migration; in midwinter he brings us up against such problems as the otter's survival in the hard months and the general question of animal intelligence. In connection with animal behaviour, the author inclines, if we understand him rightly, to a somewhat remarkable transcendental conclusion, that conscious intelligence is "the consequence of an external and superior mandate or suggestion, acting upon a suitable physical receptacle." "Assuming a First Cause, instinctive activities in the lower animals may be regarded as the comparatively simple and intelligible results of forces initiated by him, acting unerringly in prescribed directions by means of co-ordinate organs modified by evolution." In short, this lifelong student of the ways of living creatures is frankly dualistic. But he does not seek to ram his philosophy down the reader's throat.

We notice a few slips in the pages; thus Fabre's volumes are referred to as "Etudes Entomologiques," and again as "Mémoires Entomologiques," whereas the title was surely neither. But such slips are trivial in a book of great attractiveness. It is full of interesting observations; it expresses and arouses the inquiring spirit. Its happy style suggests that the writing of it must have been a pleasure, and that is certainly true of the reading. We wish there had been an index, for the topics touched on are numerous.

Principles of Aeronautics.

Aeronautics: A Class Text. By Prof. E. B. Wilson. Pp. vii+265. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) Price 22*s*. net.

THE work under notice differs considerably in conception and treatment from that usually associated with the title "aeronautics." It is very clearly written, and will be particularly valuable to advanced students of the subject for many reasons. On the other hand, it will not appeal strongly to the less advanced worker who delights to regard himself as "practical," for he will find only a "skeleton airplane" of the simplest type as a basis for all the calculations made. The more usual curves by which laboratory results are expressed are subordinated to analytical expressions. The peculiar advantages of this point of view are obvious in many places, notably in the treatment of the fall of bodies through air. Without containing such original matter as that of Bryan in "Stability in Aviation," the new volume expresses ideas more nearly those of Bryan than of any other writer on the subject.

The introduction to the book includes the ideas underlying simple flight and the aerodynamics of aerofoils, and the chapters of this section are probably of little importance. It is with the chapter on "Motion in Two Dimensions" that the serious student of aeroplane motion will begin to appreciate the book, for here are collected with concise proofs the fundamental theorems in dynamics which are otherwise only to be found by perseverance in the reading of such volumes as Routh's "Rigid Dynamics." The principles are carried step by step to the consideration of stability, and are then illustrated by example. The study of motion in three dimensions is committed to a following chapter, and starts from the apparently simpler problems relative to fixed axes and uses these as a basis for developing the theorems for moving axes. The reasons for the ultimate simplicity of the latter in relation to complex motions are given, and the treatment is direct and helpful. The last chapter in the section devoted to rigid dynamics applies the equations developed to the stability of the aeroplane. The stage reached is not further than that of English workers, and is obviously dependent on the latter for much of its inspiration; but the chapters are more complete and self-contained than any others available at the moment.

The rest of the book is devoted to "Fluid Mechanics," and here are interposed chapters on the simpler theories generally known as "hydraulics" and the more complex and unfortunately less applicable theorems of velocity potential, etc., of hydrodynamics. The ninth chapter introduces the fundamental laws of laminar motion, and develops the formula for an adiabatic atmosphere. Then follow the important Bernoulli's theorem and the Rayleigh expansion, which indicates the velocity at which air must be considered as a compressible fluid so far as the effect on the resistance of bodies moving through it is concerned. From Bernoulli's equation the laws for Pitot and Venturi tubes are developed on standard lines. Viscous fluids are dealt with in steady motion up to the calculations relating to Poisseuille's famous experiments, and a table of coefficients of viscosity is given.

The fundamental principles of dynamical similarity, which have been applied so fruitfully in aeronautics, receive attention in chap. xi., and cover the ground rendered familiar to us by the reports of the Advisory Committee for Aeronautics.

The remainder of the book is conventional hydrodynamics, and is a further reminder of the lack of success which has attended the efforts of mathematicians and others to solve the problems of the motion of fluids under conditions resembling those of normal occurrence. As a summary of formulæ the chapters have a value to advanced students.

Taken as a whole, the book is one to be recommended to those students on whom the future developments of aviation will depend, for it contains the fundamental theorems on which the science of the subject rests and must continue to rest for such period as we can now visualise.

Text-books on Chemistry.

(1) *Treatise on General and Industrial Inorganic Chemistry.* By Prof. Ettore Molinari. Second edition. Translated from the fourth revised and amplified Italian edition by Thomas H. Pope. Pp. xix+876+2 plates. (London: J. and A. Churchill, 1920.) Price 42*s.* net.

(2) *Trattato di Chimica Generale ed Applicata all' Industria.* Vol. ii. *Chimica Organica.* By Prof. Ettore Molinari. Parte Prima. Terza edizione riveduta ed ampliata. Pp. xix+624. (Milano: Ulrico Hoepli, 1920.) Price 28 lire.

(3) *A Text-book of Inorganic Chemistry.* Edited by Dr. J. Newton Friend. Vol. ix. Part 1. *Cobalt, Nickel, and the Elements of the Platinum Group.* By Dr. J. Newton Friend. (Griffin's Scientific Text-books.) Pp. xvii+367. (London: Charles Griffin and Co., Ltd., 1920.) Price 18s.

(1 and 2) DR. ETTORE MOLINARI is professor of industrial chemistry at the Royal Milan Polytechnic and at the Luigi Bocconi Commercial University in the same city, and his treatises on inorganic and organic chemistry are, apparently, mainly directed to the special character of his teaching in those institutions. Here chemical theory, in effect, is wholly subordinated to practical application, and the books are simply descriptive manuals of chemical technology, adapted to the needs of polytechnic students and suitable for general reading. They may be said to occupy a position intermediate between the general treatise on chemical theory and the specialised handbooks on chemical technology. Prof. Molinari goes so far as to say that his books reflect the change which has come over the teaching of modern chemistry. In his opinion the methods and spirit of the teaching of Liebig, Hofmann, and Kekulé no longer correspond with present-day requirements. The "beneficent impulse" which these great teachers gave to chemical studies was, we gather, too exclusively "scientific" and "theoretical." The author, however, is a little unfortunate in his argument. He could scarcely have selected three names more alive to the utilitarian aspects of chemical science, however mindful they might be of the primary purpose of their calling and profession. The whole development of certain great branches of applied organic chemistry may be said to have sprung directly from the teaching and example of Liebig, Hofmann, and Kekulé. Liebig's genius ranged over practically the whole field of the industrial chemistry of his day; Hofmann early threw himself, with characteristic zeal and energy, into the newly created synthetic colour industry, the enormous extension of which is fundamentally based upon Kekulé's fruitful conception.

Prof. Molinari insists that "general chemistry can no longer be a simple and arid exposition of fundamental laws and of the properties of the innumerable known substances, but should possess a soul which brings it into contact with the vital activities around which it clings." "The chemical text-books which have been used up to the present time do not correspond sufficiently with these requirements." "The present treatise took its rise from these considerations, and has no other pretensions than to be an attempt to initiate a work of reform in the teaching of chemistry."

These excerpts are taken from the preface to the first edition of the former of Prof. Molinari's two works cited above, in which the author sketches the general plan of his work and makes his *apologia* for its special character. In the preface to the fourth Italian edition, on which the present English edition is based, he enforces his point of view. The Great War, he contends, "has emphasised the necessity of developing chemical teaching more and more along the lines of its practical applications." Hence he has been led "to treat the material still more from the industrial standpoint." Various chapters have been considerably enlarged, "certain improvements—presumed or real—being indicated only by the numbers of the patents in question, so that the further details may be ascertained from the journals of applied chemistry." Considering the class of person to whom the work is ostensibly addressed, a list of patents restricted to their numbers, with a general reference to technical journals in which further particulars may possibly be discovered, is of no great educational value. The extension of his principles has, in fact, led the author into an *impasse*, and by carrying it still further on similar lines his volumes threaten to become unwieldy and their material ill-digested.

Although we have no great sympathy with the spirit which has actuated the author in the compilation of these treatises, and, indeed, may be said to pervade them, in bare justice it must be admitted that they contain a great mass of useful facts, and the reader who will steadily work through their 1500 pages will acquire a considerable stock of information on general industrial chemistry. But we question whether this is quite the *pabulum* on which to feed the young chemist, even if intended for technology. Prof. Molinari thinks that the slow progress, and even the ruin, of many Italian chemical industries are to be attributed to the erroneous direction of chemical training in the universities. Nevertheless, this training was presumably modelled on that of French and German schools of chemistry, and similar evil results have not followed in France or Germany. There must be other causes—social, economic, temperamental—to account for the general lack of success of which the author complains. We seriously doubt if it will be remedied in the manner he indicates. The experience of every other country in Europe which has acquired a commanding position in chemical industry is against him. It is only in America that a similar sentiment has been seen, and, until comparatively recently, America has shown no great aptitude in creating chemical industry. Now, thanks to the enormous development of chemical teaching of a university type in the United States, a great impetus has been given to the higher branches of chemical technology, especially since the war, and largely owing to the collapse of Germany. But the system of chemical training in the best American institutions is not markedly different from that which prevails in the leading European schools. Japan affords a like example. Practically all her leading teachers and technologists have been trained in Continental laboratories, and have introduced their systems into the Japanese universities and technical institutes. It would be interesting to know the views of such eminent Italian chemists as Paternò, Ciamician, and Nasini concerning Prof. Molinari's surmise as to the cause of Italy's backward condition in chemical industry. We should be surprised to learn that they would attribute it to faulty methods of teaching the science and theory of chemistry. It may turn out to be due to a superficial system of instruction in chemical technology, in which chemical theory is insufficiently considered and the methods and practice of chemical manufacture are imperfectly expounded.

(3) Vol. ix. of the "Text-book of Inorganic Chemistry" edited by Dr. Newton Friend is concerned with the elements of Group viii. of the Periodic Table, on which system of classification the entire work is based. The volume is divided into two parts, of which this instalment is the first. It deals with cobalt, nickel, and the metals of the platinum group, six in number. Strictly speaking, this is a departure from the plan uniformly followed in the preceding volumes, in which the element of lowest atomic weight in the several groups is treated of first; in this case it should be iron. It is proposed, however, to deal with iron and its compounds in a separate section forming part ii. of this particular volume. There are, no doubt, good reasons for this course. Iron occupies an exceptional position, and the space needed for its consideration may well necessitate a special section. But this fact does not necessarily require any alteration in the established plan of sequence—viz. that the element of lowest atomic weight should take precedence of its fellow-members in the group. We surmise that the only reason for the change in treatment was that on account of "the enormous amount of research" that has been carried out in connection with the properties of iron and of its compounds, delay has occurred in putting together the material. It is, of course, a small matter, and leads to no practical inconvenience. But in the interests of uniformity it is worth rectifying, which can easily be done in a later edition of the entire work.

The present volume well maintains the reputation which its predecessors have conferred upon the work as a whole. In general plan and arrangement and method of treatment it is similar to these. It opens with a chapter on the general characteristics of the elements of the group with which it is concerned. The anomaly in the position of cobalt in the Periodic Table is duly pointed out. In the table cobalt is placed between iron and nickel, although the bulk of experimental evidence goes to show that the atomic weight of cobalt is distinctly greater than that of nickel. No sufficient explanation of this anomaly has been given. It is one of those apparent exceptions to the universality and comprehensiveness of the doctrine which await solution. Similar difficulties have occurred before, and subsequent research has removed them. A case in point was met with in other members of the same group. When Mendeléeff enunciated his generalisation the accepted atomic weights of osmium, iridium, and platinum were found to be not in accordance with the previsions of the law, and Seubert showed that Mendeléeff's surmise that the numbers were inaccurate was correct. The proper sequence of the elements has now been established, although we concur with Dr. Friend that, with the exception of that of platinum, which, thanks to the careful experiments of Archibald, published in the Proceedings of the Royal Society of Edinburgh, is now well determined, the values of the other members, especially of osmium and iridium, fall very far short of the standard demanded by modern atomic weight work.

It may be hoped that we shall not have long to wait for new and more accurate determinations. These elements, it is true, present special difficulties, accentuated, no doubt, by the present scarcity of material. Indeed, the term "rare elements," originally applied to some of those of Group iii., is in these strenuous and evil days more appropriate to the members of the platinum group.

We presume that part ii., devoted to iron and its compounds, will complete the entire work of ten volumes, when we hope to be able to congratulate Dr. Friend and his coadjutors on the termination of their task. The complete treatise will form an admirable contribution to the chemical literature of this country, philosophical in plan, comprehensive in treatment, and accurate in detail, not the least of its merits being its excellent bibliography.

Our Bookshelf.

Practical Plant Biochemistry. By Muriel Wheldale Onslow. Pp. vii + 178. (Cambridge: At the University Press, 1920.) Price 15*s.* net.

THE author indicates that her book is primarily intended for students of botany, and that it should be a guide to practical work. It is stated that the volume is planned to supplement the knowledge of plant products which students obtain in their study of organic chemistry and of plant physiology. The introduction is followed by eight chapters, each giving a brief survey of some portion of the chemistry of plant life—*e.g.* the colloidal state (chap. ii.), carbon assimilation (chap. iv.), glucosides and glucoside-splitting enzymes (chap. ix.). The general matter of the chapters is followed by, or interspersed with, data upon which experimental work can be carried out to illustrate the points dealt with in the respective chapters. A list of references to original literature is given at the end of each chapter, and cross-references are frequently employed. As to errors, it is rather surprising that those in the structural formulæ for α- and β-glucose on p. 48 (where the formulæ are used to illustrate a statement concerning the two forms) should have been overlooked.

The chapter on plant bases (chap. x.) consists rather too largely of a list of names, to which are attached complex structural formulæ that are more likely to confuse the students who have "an elementary knowledge of organic chemistry" than to be of assistance to them. But for the somewhat disjointed effect resulting from the method of introducing the experimental instructions, the matter is presented in an interesting form, and on the whole there is a pleasing freedom from dogmatic assertions concerning unknown or uninvestigated chemical changes, which so frequently detract from the value of works of this type. The general survey of the problems involved in the chemistry of plant life, and the instructions for experimental work which this volume contains, should prove both useful and interesting to the class of student for whom it was written, and to many others who are interested in the chemistry of the plant world.

A. E. E.

Vergleichende Anatomie des Nervensystems. Erster Teil., Die Leitungsbahnen im Nervensystem der Wirbellosen Tiere. Von Æ. B. Droogleever Fortuyn. Pp. viii + 370. (Haarlem: De Erven F. Bohn, 1920.) 12.50 guilders.

THE author is to be congratulated on this excellent digest of the known facts regarding the paths of conduction in the nervous system of invertebrates—a work which has entailed careful reading of the extensive and complicated literature of the subject and skilful collation of the results. He gives an account of the principal issues of the researches—treated for the most part in historical sequence—on the arrangement of the sensory cells and ganglion cells and the course of their processes, so far as this has been ascertained, in each phylum of invertebrates. The internal structure of the cell and the intracellular neurofibrillæ are not discussed. After dealing with the Porifera in less than a page, there being no evidence of the presence of nervous elements in sponges, the author examines in turn the Cœlentera, Vermes, Mollusca, Echinoderma, Arthropoda, Bryozoa, Tunicata, and Amphioxus, the last-named being included because its nervous system presents a number of features in common with that of invertebrates. In some cases—*e.g.* Echinoderma, Bryozoa, Tunicata—our knowledge of the paths of conduction is extremely slight, but in others—*e.g.* Annelida and Decapod Crustacea—there is an extensive literature which has received full consideration. The digest, illustrated by 116 diagrams, shows clearly what has been done, and renders obvious how much still remains to be done to elucidate the detailed structure of the nervous system of invertebrates, for, as the author remarks, we have as yet only an imperfect conception of the various conduction paths in the ganglia of the earthworm's nerve-cord, although these ganglia have been investigated more than any other part of the nervous system of any invertebrate. J. H. A.

A Guide to the Old Observatories at Delhi; Jaipur; Ujjain; Benares. By G. R. Kaye. Pp. vii + 108 + xv plates. (Calcutta: Superintendent Government Printing, India, 1920.) Price 3*s*. 6*d*.

THIS little book is an abstract of the larger publication on the same subject which was reviewed in NATURE, vol. ciii., p. 166. It is evidently intended for travellers who have seen one or more of these curious and gigantic instruments and wish to know something about their origin. All the tabular matter and similar details have been omitted, while the clear descriptions and some of the excellent pictures have been retained. We could have wished that the author had omitted from this guide-book his remarks about the supposed scientific knowledge of Jai Singh. It cannot be denied that this man, living in the eighteenth century, not only was quite unaware of what had been done in Europe during the previous two hundred years to improve the construction of instruments, but also did not even make the slightest advance on the work of the Greek and Arabian astronomers. All he did was to copy some instrumental monstrosities erected at Samarkand three hundred years before his time, and it is no wonder that little or no use was ever made of them.

(1) *Reports on Hides and Skins.* Pp. ix + 123. (2) *Reports on Oil-seeds.* Pp. ix + 149. (Imperial Institute. Indian Trade Inquiry.) (London: John Murray, 1920.) Price 6*s*. net each vol.

IN 1916 the Imperial Institute Committee for India was invited to inquire into the possibility of the increased use of Indian raw materials within the Empire. Various committees were set up to deal with the principal groups of materials selected for the inquiry, and the present volumes are the reports of those dealing with hides and skins and with oil-seeds. In the report on the former materials (1) it is shown that the pre-war trade in "kips" was almost entirely with Germany and Austria. During the war the Government was able to utilise most of the material produced, and proposals are made for preventing the return of the trade to the countries of Central Europe. For this purpose a preferential export duty is proposed; also the leading tanners of the Empire have been approached, and they have agreed that they can utilise all the hides produced by India. Suggestions are also made for improving the quality of the hides. Statistics showing the export trade between 1910 and 1918 in raw cow-hides, buffalo hides, and goat and sheep skins have been inserted. The report of the committee dealing with oil-seeds (2) discusses the position of the trade in that commodity with England, Germany, and France at some length. It is pointed out that there is likely to be a serious shortage of fats in the world, and a system of rationing is recommended in order to secure adequate supplies to Great Britain and her Allies. It is further suggested that a preferential import tax on vegetable oils should be levied at our ports, and that there should be co-operation between the seed-crushers, the banks, the Government, and the transport companies with the view of facilitating the transit or re-export trade and of reducing the cost of production. Statistics for 1895 onwards of the trade in ten different kinds of oil-seeds produced in India are given.

Immunity in Health: The Function of the Tonsils and other Subepithelial Lymphatic Glands in the Bodily Economy. By Prof. K. H. Digby. Pp. viii + 130. (London: Henry Frowde, and Hodder and Stoughton, 1919.) Price 8*s*. 6*d*. net.

IN this book Prof. Kenelm Digby discusses the functions which may be performed by such structures as the tonsils, the intestinal lymphoid follicles, and the vermiform appendix, all of which are essentially lymphoid organs grouped by the author under the term "subepithelial lymphatic glands." The disadvantage of these structures in the body is their proneness to bacterial invasion and infection. The tonsils and appendix are, moreover, frequently removed by operation without any apparent effect due to their loss. The utility of these glands has, therefore, been doubted, and the appendix is commonly regarded as a vestigial organ in process of reduction. It is noteworthy that all these structures are located in situations—mouth, throat, and intestine—where large masses of bacteria are present, that they freely ingest bacteria, and that they occur only in birds and mammals, the highest and most differentiated of animals.

The hypothesis put forward by the author of the use of the subepithelial collections of lymphoid tissue is that they play an important function in immunising the body against pathogenic bacteria in proximity to the tissues—they are immunising stations, so to speak. The several tonsils form a protective circum-pharyngeal ring, and the Peyer's patches, appendix, and solitary follicles are distributed over the intestine—localities which are most in need of protection from bacterial invasion. In the stomach, on the other hand, lymphoid structures are almost absent, but here the acid nature of the secretion is sufficiently protective without their aid. The argument is sustained by a number of anatomical, microscopical, and clinical observations and data, and we think the author has made out a good case. The book is illustrated with several original drawings and diagrams. R. T. H.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The British Association.

THE discussion about the future of the British Association has turned mainly upon what may be called the "scale effect" consequent upon the vast increase in the activities connoted by the advancement of science. The effect is real enough; the decimal point has been moved on by one or more places in the course of the three-quarters of a century of the life of the Association.

And it is not only science of which this is true. We see the same kind of problem in such common affairs as university education, Parliamentary government, and Treasury control of expenditure Formulæ which were worked out fifty years ago or more for a certain scale are still being used, but they are not applicable now that the scale is increased tenfold or a hundredfold. Each case has, no doubt, an appropriate solution if we have the courage to face the facts and deal with them instead of ignoring them.

But as regards the British Association there is a social side of the question which has not received much attention. The Association does not select a town out of all England, Wales, Scotland, and Ireland at which to hold a summer meeting. It is invited to honour a town with its assemblies. The first magistrate and other leading citizens attend a meeting of the Association and offer the hospitality of their city.

If we go back some years beyond the beginning of the present century, the invitation meant an offer of the personal hospitality of the citizens to the active members of the Association. In those days the prosperous householders of the larger towns and their neighbourhood had spare rooms which were intended to be used, and were used, for the purpose of entertaining friends. The devotees of science were interesting people with whom to spend a week was a pleasure worth seeking. To offer hospitality for an astronomer from Ireland, a mathematician from Cambridge, an economist from Oxford, a geographer from London, a geologist from Wales, or a chemist from Scotland was not altogether a one-sided bargain. What these guests did with the time devoted to the discussion of recondite matters of their own science in the Sections was not the *quid pro quo*. Their hosts would become members or associates as part of the invitation, and possibly attend the Sections in order to be able to show their guests the way; but their insight into science and its methods was obtained by having one or more successful exponents of science staying in the house. They would probably learn more of what went on in the Sections from their guests' account of it over breakfast than by hours of personal attendance in a room where the difference between drivel and discovery is not always signalled. A party of half a dozen guests at one of the larger houses was brilliant company well worth entertaining.

The president's address dealt with the moving scientific topics of the day, the evening lectures were the last word in scientific exposition. The evening parties gave guests and hosts an opportunity of widening the circle of acquaintance, and the excursions often developed acquaintance into friendship. The guests left with a feeling of personal obligation which was not without opportunity of requital. If that feature of the British Association is lost in the effort to make the world better for somebody else, the loss of the grace of domestic hospitality is profound.

At the time it was not only a simple and natural grace, but also an essential preliminary to an invitation. To house a thousand visitors in the early days of the Association otherwise than by private hospitality would have puzzled the most energetic of local secretaries.

Very little money beyond the cost of the ticket came into the question. On the joint invitation of the authorities of a town, halls were available for meetings and other facilities provided. There remained to be paid for an abundant supply of stationery —which members appreciated, but not always with due respect—the printing of the journal and other incidental expenses, and one or more evening parties.

As time went on personal service became merged in or supplemented by a guarantee fund. The actual expenses of a meeting of the British Association do not appear in its accounts. In later years it was a shock to learn that people who had spare rooms actually absented themselves from home at the time when the Association was known to be coming; when it was our turn to act as hosts we thought the plea of an inexorable summer holiday rather a shabby excuse. But from the occasion of the meeting of a certain jubilee year hotel accommodation became the rule for the most active members of all the Sections, and members may now go through a meeting of the Association without making a single acquaintance in the town. There is no small danger of the meetings being changed from occasions for the exercise of graceful hospitality into the periodical lumbering of a rather ineffective machine.

I have no particular wish to be simply *laudator temporis acti*. If we have definitely turned our backs on the past and the pleasure of company has vanished, with all that that must have meant for a town in the dissemination over the table or round the hearth of information about science and education, where to go, and what to see or to read and all the rest, are we now instead to deliver within a week, in return for a guarantee fund, something which will be recognised as its equivalent in scientific exposition? If so, we shall want a strength of organisation that is at least quite uncommon in the scientific world, and I do not envy the organising secretary who has the duty in hand. The existing machinery is certainly not sufficient. The equivalent of twelve men enlightening a great town on the mysteries of all the sciences by talking for twelve hours each in a single week gives me the same impression as "seven maids with seven mops sweeping for half a year."

> "Do you suppose," the Walrus said,
> "That they would make it clear?"
> "I doubt it," said the Carpenter.

What I am quite clear about is that if you would allow a company of meteorologists, magneticians, seismologists, and other students of the earth and the sky to meet together for a week and discuss matters of common interest, the community that entertained us should not complain for lack of interest; but if you tell me that I have to expound modern meteorology to the man in the street in a paper or discussion of an hour and a half, and that ninety-five other people will do the like for their respective subjects within the week, I give it up. I know it cannot be done, even if I am allowed unlimited use of technical language, which appears, somewhat irrationally, to annoy some of your correspondents. I wonder why? Would they wish us always to paraphrase electricity as that which is produced when amber is rubbed with cat-skin? Science without technical language is very much like "French without accents."

We might do better if we concentrated our attention on the successful execution of what ostensibly we attempt. Let us give up arranging meetings at a time when we know, from the circumstances of the case, people cannot and will not attend, and give up also the formality of voting on questions which have been neither read nor circulated. If the popular evening lecture has ceased to be attractive, let us devise some other form of after-dinner appeal with scientific accessories; the Red Lions ought not to lag behind the kinema. If we wish to address an audience, let us address the audience; if we have something to say, let us say it; if we wish to make ourselves heard, let us make ourselves heard or know the reason why; and, finally, if the proceedings are reported, let the Sections make skilled reporting a part of their business. The word recorder seems to have got adrift from its moorings lately. Machinery in motion always has an irresistible attraction; if the meetings of the British Association presented examples of scientific purpose, perfectly managed and scientifically executed, they would be acceptable in many large towns, although the subject-matter might not all of it appeal to the man in the street. It ought not to be forgotten at this particular time that in 1903 Sir Norman Lockyer endeavoured to strengthen the hold of the British Association by keeping its organisation in operation throughout the year, and when the Association declined the suggestion, sought other means of giving expression to his views.

October 3. NAPIER SHAW.

IF you do not consider the subject of the British Association, which has been so fully discussed in recent issues of NATURE, to be now exhausted, I should like to state briefly how it appears to me.

The Association had at first six "Committees of Sciences." They were in 1835 converted into Sections. The following year another Section was added for Mechanical Science. The Sections continued to be seven only for the next fifty years, when H (or Anthropology) became a separate Section. Botany, Physiology, Educational Science, and Agriculture have since been added, making up the twelve existing Sections.

The Association was not in a hurry, for it was well aware of the practical difficulties arising from a multiplicity of Sections, but these added Sections have certainly not detracted from its popularity. The Conference of Delegates is another modern development of the work, and keeps interest in that work alive in many parts of the country.

A still more recent extension of the activities of the Association is the Citizens' Lectures, which were very successful at Cardiff. The meeting there was a good one, and would have been much larger but for the exorbitant railway fares. The address of the president, Prof. Herdman, was both brilliant and practical, and will, I hope, be fruitful in the near future. EDWARD BRABROOK.

October 1.

The Examination System.

PROF. H. E. ARMSTRONG's address on the university problem in London, published in NATURE of September 23, induces me to make the following remarks with special reference to the examination system in England.

The chief defects are:

(1) Expecting a candidate to remember details necessary for giving a complete answer to an essay question.

(2) Expecting him to answer a lot of questions in three hours.

This has been improved on recently by giving highest honours for five questions out of ten. But, in my opinion, at most four essay questions in three hours are all that should be expected; and in the case of difficult mathematical or similar questions not more than three.

It is notorious that the best men do not always come out at the top, partly because some hate to be hustled, others think slowly, and others still are not walking encyclopædias even in their own subject.

I know of an institution where the examinations are quite as well managed as in other educational institutions, though I admit the syllabus is so large for the time allowed that there is a good deal of "cram" necessary. As a rule, a student who is good at any subject seldom comes out very high up, whereas others who often have no taste or gift for a subject are placed at the top Also, there is a student who can come out top of nearly every examination because he is good at examinations.

I suggest the following improvements:

(1) That students be continuously examined throughout the period of their instruction by weekly or monthly papers and practical work.

(2) That there be fewer questions set in essay or problem papers. Details I have already suggested.

(3) That manuscript note-books of any kind be used by students in all theoretical as well as practical examinations, particularly in scientific subjects.

OXFORD M.A.

An Awkward Unit.

THERE has lately been introduced on the Daily Weather Report a small map showing barometric tendency. The barometric change from 4h. to 7h. is given as "a multiple of the half-millibar, that unit having been found convenient for reading the barograms and adopted for telegraphic reporting" (*Meteor. Mag.*, August, 1920, p. 150).

It is to be regretted that European meteorologists appear to be unaware of the fact that the megadyne or megabar atmosphere was correctly defined by Prof. Theodore Richards in his classic paper on "New Methods of Compressibility," published by the Carnegie Institution in 1903, and in later papers. The bar is a pressure unit expressed in terms of force, and is equal to one dyne per square centimetre. This is the bar of American chemists and physicists, and has been in use at Blue Hill Observatory since 1914. The term "millibar" which meteorologists hastily adopted in 1913 appears to us to be a misnomer for "kilobar."

There are many solid arguments in favour of the use of a megabar atmosphere. These will not be repeated here, but it may be pointed out that the expression "*multiple of a half-millibar*" is awkward. It is so much easier to use the proper definition "500 bar."

Isallobars can then be drawn for any desired value, while it would be rather troublesome to express the same values in fractional parts, such as "*one-fifth millibar*," meaning a 200-bar change.

ALEXANDER MCADIE.

Harvard University, Blue Hill Observatory, Readville, Mass., September 23.

Absorption Spectrum of Hydrogen Chloride.

THE unexpected satellites which Imes (*Astrophysical Journal*, November, 1919) found beside each line in the HCl absorption band at $1{\cdot}76\mu$, and which measurements of his curves show to have an average wave-length $16 \pm 4 \cdot$ Å. longer than the lines which they accompany, are readily accounted for as due to the heavier of the two isotopes, atomic weights 35 and 37, of which Aston (*Phil. Mag.*, vol. xxxix., p. 611, 1920) has shown ordinary chlorine to consist. An approximate theory shows the wave-length of the band centre to vary as the square root of the effective mass, $m = \frac{m_1 m_2}{m_1 + m_2}$, where m_1 is the mass of the hydrogen nucleus and m_2 that of the chlorine atom. Taking $m = 35/36$ for the lighter and $37/38$ for the heavier isotope, the calculated difference between the wave-lengths of corresponding lines for the two isotopes comes out 13 Å. This is much larger than the differences of about 0·004 Å. which have been found between lines of the isotopes of lead (Aronberg, *Astrophysical Journal*, vol. xlvii., p. 96, 1918, and Merton, Roy. Soc. Proc., A, vol. xcvi., p. 388, 1920).

I hope soon to publish a more detailed account of the theory and measurements of these lines, probably in the *Astrophysical Journal*. F. W. LOOMIS.

New York University, University Heights, New York City, U.S.A.

A New Visual Illusion.

A VISUAL illusion which I have never seen referred to may be of interest. If the gaze is steadily fixed for a few minutes on a spot in the descent of a waterfall which has a fairly long unbroken fall, and afterwards quickly transferred to the adjacent hillside, the hill itself appears to rise slowly as a whole, somewhat as though it were an elevator. The same result may be obtained by looking fixedly at the broken surface of a rapid and fairly wide stream; on directing the eyes suddenly to the opposite bank this appears to move slowly up-stream.

The illusion seems to me to be due to the rapidly moving water tending to carry the vision along in its own direction, as occurs when any moving object is unreflectively observed. But while the eyes are kept fixed on the selected point, this tendency becomes counteracted by a series of slight and rapid but unconscious muscular efforts which prevent the eyes from following the motion. After the gaze is removed to the adjacent stationary ground, these muscular efforts automatically persist for a short time, thus causing the ground to appear to move in the opposite direction to that of the water. But possibly a more accurate explanation can be advanced.

J. E. TURNER.

55 Allerton Road, Mossley Hill, Liverpool.

Plant-life in the Cheddar Caves.

SINCE reading the letter relating to plant-growths in the Cheddar caves by Mr. L. Pendred which appeared in NATURE of August 5, I have been able, by the courtesy of Messrs. Gough, to examine the plants *in situ*, and to secure a quantity of material for fuller investigation.

The green patches on the cave-walls were found to consist of a small green unicellular alga. The loose cave-earth on the sides of the cave-paths yielded a few specimens of fern prothallia. The plant patches in the neighbourhood of the electric lights were found to consist of the following species of mosses: *Plagiothecium denticulatum, Amblystegium serpens*, and *Fissidends bryoides*, all of which are fairly common. My determinations of these species have been confirmed by Mr. A. Gepp, of the botanical department of the British Museum (Natural History).

I think Mr. Pendred's suggestion that the spores were carried into the caves by the spades or on the clothes of the workmen is highly probable, or that the excellent ventilation maintained in the caves may have resulted in the spores being carried in by air-currents. In any event, the dampness and the air-currents would be factors assisting in the subsequent germination of the spores.

EDITH BOLTON.

Armstrong College, Newcastle-upon-Tyne.

Old Maps.

REFERRING to the kind notice of my presidential address to the Conference of Delegates at the Cardiff meeting of the British Association in NATURE of September 16, p. 90, time did not permit details to be given of the evolution of Scottish maps, or those of Faden, etc., would certainly have been referred to. The large map of Cary's which I mentioned was not the one you surmise, "with the coach roads coloured in blue, which is on the scale of five miles to an inch," but the map on the scale of *two* miles to an inch. The typist or printer, quite pardonably, has apparently mistaken my "two" for "ten." With regard to Griffith's map of Ireland, I still contend that the date of the map "to be included as a classic" is that of 1853. I know there was a slightly improved edition in 1855; there is one in the library of the Geological Society of London, but that was the *third* edition, and not the second, as stated in your columns. T. SHEPPARD.

The Museum, Hull.

I CONFESS that I was not aware of a large map by J. Cary on the scale of one inch to two miles. The one that I mentioned, with mail-coach routes in blue, is of constant service to me. Great confusion has been caused in regard to Griffith's geological maps of Ireland by references to them as successive editions, as if all were published and on the same plan and scale. Maxwell H. Close (Journ. R. Geol. Soc. Ireland, vol. v., p. 136, 1879) is, I think, responsible for calling a geological map exhibited in 1815 "the first edition," but he carefully added that it was never printed, and he evidently meant only "the first form." He emphasised the fact, by underlining the word, that W. Smith's map of England was *published* in the same year. Griffith's map of 1835 was, according to John Phillips (*op. cit.* above, p. 138), large, but also unpublished. Phillips utilised its details in 1838. In 1838 a coloured geological map by Griffith was issued in connection with the Report of the Railway Commissioners, scale one inch to ten miles. A few months later in the same year his large map (one inch to four miles) appeared under the same auspices, and was, as Close tells us, sold to the public from March 28, 1839. These two maps of 1838 can scarcely be called two editions of the same groundwork, since they were both simultaneously in preparation. The large map of 1838 (published, with date, in 1839) was completely revised and re-engraved, with the addition of mineral localities, and issued in six sheets in April, 1855, the date being engraved on it against Griffith's signature. The map of 1853 was a small one (one inch to sixteen miles), and was issued in a guide to land-valuers.

The plates of the "classic" map of 1855 are preserved in the Ordnance Survey Office, Dublin. From inquiries that I have recently made of this office and of the original publishers, no coloured copies seem now to be available.

It is rarely that one has a chance of correcting Mr. Sheppard. THE WRITER OF THE NOTE.

The Iridescent Colours of Insects.[1]

By H. ONSLOW.

II.—DIFFRACTION COLOURS.

THE structure of the scales of a number of iridescent butterflies was described and illustrated in the first article. The colours of many of these insects are undoubtedly produced by thin plates, either of chitin or of chitin and air. In a few instances, however, the structure gave no indication whatever as to how the colours were evoked.

Some definite modification of the structure gives rise to the principal colour, but all the minor details, such as the exact shade and the quality of the surface, which are so characteristic of any particular species or variety, are determined by

FIG. 1.—The Green Hairstreak (*Thecla rubi*). Showing the iridescent green under-wings, which are the same colour as the leaves. (Natural size.)

the shape and position of the scales, the amount and form of the surface modelling, and the colour and localisation of any accompanying pigment. Consider, for instance, the shimmering appearance of the familiar Green Hairstreak (*Thecla rubi*), Fig. 1, which makes this insect so difficult to find, when it sits with its wings folded high overhead, looking like a green leaf dancing in the breeze. The appearance of the green scales is well known, *1* (Fig. 2), and a discussion on their colour, and on the cause of their characteristic reticulation, was carried on in the *Entomologist's Record*, vol. vi., p. 35, 1895.

When observed by reflected light under the microscope, this shimmer is seen to be due to the spangled appearance of the scale, which is divided into many small, irregular areas, *o*, which reflect a green glitter of varying intensity, like so many sequins. These areas are divided from one another by pale lines, which form a reticulation. By transmitted light the reticulation shows as a transparent line, and, moreover, the brown colour of the polygonal areas is seen to vary considerably, some being dark brown and very opaque, and others pale yellow and transparent. Now the intensity of the green light varies in exactly the same way as this brown colour, the darkest and most opaque areas reflecting the brightest green. The iridescent colour is probably caused by a periodic structure not unlike that described in *Papilio ulysses*, the normal brown

FIG. 2.

1, Green under-scale of *Thecla rubi*, showing reticulation. *o*, dark polygonal areas.

2, Section through scale of *Hypomeces squamosus*, var. *durulentus*, showing stratification. *c*, surface cuticle.

3, Scale of the same weevil, *in situ*. *r*, root.

4, Plan of scale from the same weevil.

5, Cross-section of green scale of *T. rubi*, showing places *b*, where the scale is looped up, corresponding to the reticulation in *1*. *s*, striæ.

6, Tangential section through the wing-case of *Heterorrhina elegans*, made through the plane *ab* of section 7, showing the tops of the doubly refractive rods.

7, Cross-section through the same wing-case, showing layer of rods r_1 and a deep layer r_2. *c*, the surface cuticle.

All these sections, with the exception of *5*, were drawn to the scale μ=1 mm. with Zeiss 2 mm. apochromat, N.A. 1·4, and Comp. Oc. The scale *1* has a magnification of about 100 diams.

colour of the scale concealing any trace of this structure that might otherwise have been visible. The explanation of the reticulation and the spangled appearance it produces becomes at once evident on cutting a transverse section, *5* (Fig. 2), through the scale. It can be seen that the network corresponds to the thin places on the scale, *b*,

[1] Continued from p. 152.

where it appears, as it were, to have been looped up. The bright green areas then correspond to the thickest portions of the scale. This is evidently only another example of the intensification of the colour produced by an underlying screen of dark pigment, which absorbs the excess of white light that would otherwise be reflected to the eye, causing the colour to become much desaturated.

Diffraction of Light by "Gratings."

Colours due to barred structures, or "gratings," which diffract light in the usual way, cannot be said, in Lepidoptera at least, to be of very great importance. They do, however, often produce effects which, though of secondary value, contribute a good deal to the final result. The fact that most scales appear to be marked with striæ, which form gratings of suitable dimensions, has sometimes given rise to the idea that most insect colours are produced in this way. This is evidently not the case, for iridescent scales are sometimes smooth, and, moreover, plain black and white ones are often striated. Impressions or replicas were therefore taken of many scales in a special preparation of collodion, in order to isolate the effect of the surface structure from any other colour-producing factors. Good "gratings," showing normal lateral spectra, were obtained from most insects, such as the Large White (*Pieris brassicae*), but if the film was dyed, the colours became feeble or disappeared. This indicates that diffraction colours are, as might be expected, discernible only on very pale or colourless scales. The existence of diffraction colours can be clearly demonstrated by the following experiment. An impression was made from the pale blue surface scales of *Morpho achilles*, in such a way that at least one patch adhered to the collodion film. On tipping the grooved film so as to cause the spectrum colours to pass across the patch of scales, it could be seen that their normal blue colour became intensified in the violet region of the spectrum, changed to mauve or pink in the red region, and returned to its original shade on passing into the infra-red. When this effect has once been seen, a very similar play of pale mauve and pink diffraction colours can be discerned on examining the wings of *M. achilles* itself, and of certain similar insects.

Very brilliant colours are shown by scale-bearing beetles or weevils, like the Brazilian Diamond Beetle (*Entimus imperialis*) (Fig. 3). Michelson admits these colours to be an exception to the general rule, by which he attributes all insect colours to selective metallic reflection, or surface colour. He believes the colours of these beetles to be due to gratings within the scale itself, since as soon as a fluid can enter the scales through a rent or tear the colour vanishes. Moreover, since the light is concentrated in a single spectrum, he is obliged to assume that the grating has bars, which are asymmetric or prism-shaped, so that they refract the incident rays in the same direction as the diffracted rays of the lateral spectra. For several reasons it is difficult to believe that such saw-tooth-shaped gratings are responsible for the total colour effect. For instance, the very saturated complementary colours seen by transmitted light, and the monochromatic character of the reflected colours at different angles, demand a form of grating structure even more complicated than that described by Michelson, such, for instance, as that named by Prof. R. W. Wood the "échelette grating." Moreover, though as a rule no structures are seen, a very well-defined stratification, 2 (Fig. 2), sometimes appears in cutting sections of certain scales, as in the pink weevil, *Hypomeces squamosus*, var. *durulentus*. This stratification can be seen in plan, 4 (Fig. 2), and appears to exist throughout the scale, giving it in section the crossed appearance of the strings of a tennis racquet. It seems probable that such a structure would contribute a large share to the total colour effect. Further, a suitable irregularity in the periodicity or thickness of the plates

FIG. 3.—The Brazilian Diamond Beetle (*Entimus imperialis*), a large, iridescent weevil. The black pits on the wing-cases are lined with gem-like scales. (Natural size.)

would account for the existence of the very saturated colours of some weevils, and of the very pale and desaturated colours of others.

Dispersion of Light by Prisms.

If Michelson's hypothetical prism- or saw-tooth-shaped gratings are omitted, no case of prismatic structure has been met with. It is true that Dr. H. Gadow has explained how the colours of certain feathers might be the result of the roughly prism-shaped structure of the barbules. He supposed that these were placed in such a way, in respect to each other, that each barbule obscured part of the spectrum formed by the preceding one, so that partially monochromatic colours would result. Numerous theoretical and practical considerations, however, make this suggestion highly improbable.

The Scattering of Blue Light due to Small Particles.

The investigations of the late Lord Rayleigh, and others, have shown that the blue of the sea, sky, snow and even tobacco smoke is caused by particles which, being very small compared with the wave-length of light, scatter the blue waves to a much greater extent than the longer red waves. Several colours can be produced in this way, as, for instance, the blue, green, and purple of certain feathers, which are matt, and do not change colour with the angle of incidence.

Such feathers show a faint yellow colour by transmitted light, and any pressure which destroys the structure also destroys all colour. The small bodies which scatter the light are in this case said to be exceedingly minute air-canals, which, on being filled with fluid, lose this property. In the case of feathers, as well as of certain animals, such as green frogs and many reptiles, the green is said to be due to the additional effect of a yellow pigment which is superimposed on the blue colour, as in the case of *Ornithoptera poseidon*, already described. There are also some exceedingly brilliant marine copepods which owe their colours to a prismatic layer of minute rods, said to be small enough to scatter coloured light.

In most beetles the metallic colours are seen to come from the surface, and the slightest scratch on the elytron removes all the colour. In the case, however, of certain emerald-green and blue Cetoniids, the colour appears to come from underneath the surface, which gives the wing-case a curious enamelled appearance. This peculiarity can be instantly recognised, and, moreover, the colour, though matt, is seen to persist, even when the surface layer has been removed with a scalpel. This layer has been called the "*Emailschicht*," and when sections are cut from it tangentially to the surface, *6* (Fig. 2), they give a bright green colour by reflected light, even when mounted in fluid media. A transverse section, 7 (Fig. 2), was cut from this layer of a beetle called *Heterorrhina elegans*; it is seen to be made up of very fine rods of chitin, r_1, about 1μ apart, and arranged at right angles to the surface; r_2 represents a second layer of rods at a lower depth. The section, *6* (Fig. 2), made through the line *ab* of section 7, reveals the cut ends of the rods. Thus the light, on striking the wing-case, is reflected from the tips or ends of a large number of these rods or pillars, and it seems possible that they may scatter the light in the same way as the air-canals do in the case of birds' feathers. It must, however, be pointed out that the above theory demands that the rods, or other bodies which scatter the light, should be appreciably smaller than the wave-length of light; that is to say, not much larger than a complex molecule. It is, however, uncertain whether bodies of the same order of magnitude as light waves (*i.e.* $0{\cdot}5$–$1{\cdot}0\mu$) can produce analogous colours. A very remarkable point about these rods of chitin is that under crossed Nicols they appear to be doubly refractive. This suggests that there may be some analogy with doubly refractive striated crystals like the tourmaline.

(To be continued.)

Physical Anthropology of Ancient and Modern Greeks.

By L. H. DUDLEY BUXTON.

IN classical times a clear distinction was drawn between Greek and Barbarian; Aristotle, indeed, claimed that they differed physically. To a certain extent it may be shown that in detail Aristotle had right on his side, but it can also be shown that Greek differs physically from Greek, so that his general thesis is untenable. It is true that most of our evidence rests on measurements made on modern Greeks, but there are data to prove that the latter possess physical characteristics not differing essentially from those of the former.

Among recent writers it has been generally admitted that at least two races are represented in Greek lands—the "Mediterranean" and the "Alpine." The former are short in stature, dark in colouring, and long-headed, typically represented by the Spaniards; the latter are fairer, and often, but not invariably, have auburn hair and hazel eyes, and vary very much in stature. The Eastern branch of the Alpines are usually known as "Armenoids." They are distinguished by their short, high heads, which are extremely flattened in the occipital region. It has also been suggested that long-headed, blond giants—Nordic—have contributed to the population of Greek lands.

Of the aboriginal population there is little evidence at present. Von Luschan believes that, at any rate in Anatolia, the earliest people were Armenoids, and in the Morea Prof. Myres considers that the Alpine strain is certainly ancient and may even be primitive. Early material is, however, so rare that it is easier, in stating the problem before us, to reverse the time process and to study the ancient people after the modern, about whom we are better informed.

The mean cephalic index in Greek lands to-day varies from 79 in Crete to 84 in the island of Leukas. None of the Greeks are as long-headed as the pure Mediterranean type, such as we find in a comparatively pure form in Corsica or Spain and in a less pure form in Egypt; nor, again, are they as broad-headed as the Lycian gipsies, who certainly represent pure Armenoids. If we group such cephalic indices on the living as are available, we obtain three classes: (1) Under 81, Cretans, Peloponnesians, Lycians (Greeks and Turks); (2) intermediate, Messenians and Cypriots; (3) more than 84, Leukadians, Albanians, Lycian gipsies. It would appear unlikely that this grouping is of any significance, if we turn from these figures to the variation, conveniently measured by taking the square root of the average square deviation from the mean (standard deviation). The Lycian Greeks and Turks have a very high standard deviation, suggesting considerable mixture, and the standard deviation of the cephalic indices of all the Greeks is sufficient to suggest a greater or less degree of intermixture. The condition of intermixture in Cyprus can be seen in Fig. 1—a photograph of a Cypriot woman and her three children. The elder boy might easily have been taken for an almost pure Armenoid; the younger had many characters usually associated with the Mediterranean people. The inadequacy of grouping by cephalic index alone is confirmed by the very great local differences to be found between groups of villages in Cyprus, to take one example only. The villages on the north coast have a cephalic index of 81·9, those round the Bay of Salamis, just the other side of the hills, an index of 83·4. There are similar local differences in Crete.

FIG. 1.—A Greek family, showing the two extreme types. The father (not shown in the photograph) had fair hair and blue eyes. The contrasted contours of the backs of the head should be noticed.

If we compare ancient crania with modern heads it would appear that the modern Greeks are slightly more round-headed than the ancient inhabitants of the same places. But this difference is not of any great significance, and there is a greater resemblance between the modern inhabitants of any one place and their predecessors than between the modern inhabitants of two neighbouring areas; in other words, the variation of types at any stage is horizontal, and not vertical, in the strata. First, the cranial indices, then, of the Greeks exhibit great variety, sufficient to suggest ethnic admixture. Secondly, this admixture has not been evenly distributed, and local and distinct sub-races have been formed, the mean of which forms a series of types, one of which is illustrated in Fig. 2—a type which has neither the breadth of head of the Armenoid, nor the length of head of the Mediterranean. So distinct are these sub-races that where crania over a long period have been obtained the cephalic index of one modern village more closely resembles that of their Bronze-age predecessors than that of a neighbouring area. Thirdly, there is archæological material which suggests that the mixture of race is early, possibly Neolithic in Leukas, certainly Bronze-age (or before) in Cyprus and Crete.

So few complete ancient skeletons have been collected that we cannot estimate the stature of the ancient Greeks. Among the modern, we find that

FIG. 2.—An intermediate type, with hazel eyes and brown hair.

the Cypriots and Cretans are the tallest, averaging about 5 ft. 6½ in., and the Leukadians and Peloponnesians the shortest, being about an inch shorter. So few measurements are, however, at present available that the stature must remain uncertain.

Data for hair and eye colour are rather scanty. The number of blue-eyed individuals is not, however, so few as might be expected. In Cyprus they form about 10 per cent. of the population, and most authorities are in agreement that blue eyes are not rare in Greek lands. It is this occurrence of light eyes that has made some writers postulate the presence of Nordics among the Greeks. Speaking from personal experience, the author was struck by the continual association of blue eyes with a very Armenoid type of skull in Cyprus and elsewhere—the taller boy in Fig. 1 is a good instance of this type—and though, historically, no doubt Nordics have filtered into the

Eastern Mediterranean at various times, the evidence of blue eyes is certainly insufficient to establish their presence as a recognisable element in the population.

The distribution of other characters, such as the form of the nose and of the orbits, cannot at present be plotted, as the evidence is scanty. Such measurements as have been made on the face suggest that, among the Greeks at any rate, broad faces accompany broad heads, and *vice versa*.

If we sum up the evidence afforded by all the physical characters which have been measured, we find that the Greeks probably represent a very old hybrid, older than the beginnings of the Bronze age. In Cyprus the earliest skulls examined were found associated with red polished and white painted ware, and were clear examples of this hybrid. We cannot at present say whether these early Greeks formed this physical type in the island or before they reached it. Elsewhere, so far as our scanty data go, the same tale seems probable. In each little district there is a mixture; sometimes the population of widely distant spots is similar; sometimes villages close to one another differ. It must be remembered that the geography of Greek lands favours the development of local strains, communication being often very difficult. There does seem to be a physical background to the differences between village and village in classical times, and to the struggles between Athens and Sparta. Most of the inhabitants of the Eastern Mediterranean, however, are also of this hybrid stock, and so Aristotle's dictum seems unjustified. There is no physical background for Hellas as a whole. Our present evidence suggests that the degree of mixture is fairly uniform throughout, though the results of the mixing may be different. Lycia, however, presents a far greater degree of heterogeneity; this heterogeneity did not escape the notice of Herodotus, who says that the Lycians were Cretan immigrants into a country with a previous Minyan population, with a third element from Attica.

There is little reason to doubt the generally accepted statement that the two stocks which have formed this hybrid are Mediterranean and Armenoid. The former is found in a comparatively pure state to the west and south of the Greek world, the latter sporadically in a pure state among the Greeks of Anatolia, and may even occur, though we have no evidence at present, in the Balkan Peninsula itself.

Obituary.

Alfred E. Fletcher.

By the death of Alfred E. Fletcher, at the great age of ninety-four, the country has lost a scientific worker who, in his particular sphere, exercised on chemical manufacture a powerful and healthful influence. Born in 1826, Fletcher completed his school education in Berlin, and was employed for a time on railway surveying. He relinquished his career as an engineer in order to attend the science classes at University College, London (being debarred as a Nonconformist from attending the older universities), where he studied mathematics and chemistry, for which he received the gold medal in 1851. In the following year he was elected a fellow of the Chemical Society, and afterwards began a series of researches on artificial colouring matters, a field of inquiry which had been developed by Perkin's discovery of mauve in 1856, and greatly stimulated by the work of Hofmann and his pupils at the Royal College of Chemistry. Discouraged by prolonged litigation on the subject of a patent for a new colour process in which he was interested, Fletcher accepted in 1863 the post of assistant to Dr. Angus Smith, the first Chief Alkali Inspector. The origin of this department, which played so large a part in Fletcher's subsequent career, was the numerous complaints from farmers owing to the fumes from alkali and other chemical works. These fumes arose mainly from the discharge of hydrochloric acid in the manufacture of salt-cake. These and other acid vapours destroyed vegetation over large areas.

Under the Alkali Act of 1863 trained chemists were appointed to control this industry. The result of such inspection was soon apparent. The acid, which has since become a staple and profitable product of the process, was absorbed in towers by passing the gases through a descending stream of water. This is not by any means the only example whereby the alkali inspectors have helped the chemical manufacturer to utilise his noxious by-products to his own advantage and to that of the public.

As assistant, Fletcher devised an ingenious aspirator for extracting flue gases for analysis, and also invented an anemometer for determining their rate of flow. In 1884, on the death of Dr. Smith, he succeeded him as Chief Inspector, and continued in that office until his retirement in 1895.

Fletcher's activities were not confined to clearing the atmosphere from noxious fumes. He entered upon a campaign against the smoke nuisance, which he continued for thirty years, embodying his views in a series of articles, addresses, and pamphlets. He was, so far as the writer remembers, a strong advocate of a centralised inspectorate of all factory chimneys on the lines of the Alkali Act, and set an example of domestic heating without smoke by installing a central warm air system in his own house, details of which he published in the Press and technical journals. He also assisted the Scottish Office in the administration of the Rivers Pollution Act.

Fletcher married in 1858 Sarah Elizabeth, eldest daughter of Richard Morley, of Leeds, and is survived by his wife, six sons, and three daughters.

J. B. C.

D. H. Nagel.

By the death of D. H. Nagel, of Trinity College, Oxford, science has lost an advocate who did much to remove the prejudice keenly felt in Oxford thirty years ago, and the University has lost a teacher remarkable for the thoroughness, the understanding, and the sympathy which endeared him to many generations of undergraduates.

In the examination for the open Millard Scholarship in Natural Science in 1882 Nagel was the only candidate who gained distinction both in the science subjects and in the optional classical paper. Elected Millard scholar, he worked under the writer (then Millard lecturer at Trinity) in the newly equipped laboratory in Balliol, between which and Trinity a doorway had been opened in 1879—a novelty in inter-college communications which was guarded with some anxiety by the college deans on each side, and usually referred to as "the scientific frontier."

As an undergraduate Nagel was distinguished by the width of his scientific interests; he was one of the few who attended professorial lectures outside their own subjects, and his enthusiasm may be said to have resuscitated and kept alive some of the courses in geology and mineralogy which did not form part of the usual honours schools. In addition to science he studied languages and gained a University exhibition in German.

Nagel took a first class in chemistry in 1886, and in the following Michaelmas term became demonstrator in the laboratory, and succeeded the writer as Millard lecturer in 1888.

The Balliol laboratory was soon extended into adjacent cellars to meet the needs of the two colleges, and in 1904 a considerable addition was made on the Trinity side of the "frontier," when the two colleges undertook to give practical training in physical chemistry as part of a general scheme for honours men in the University. In planning and supervising this course Nagel's knowledge and judgment found full scope.

At the opening of his Oxford career Nagel was one of the founders of the Junior Scientific Club, an institution which has been particularly successful in bringing together men engaged on different lines of scientific work, and of its members none were better equipped than Nagel by study and sympathy to understand and elucidate the relations of one branch of science to another. It was this faculty that gave him his unique position in Oxford when he settled down as fellow and tutor of his college.

It has been said of Nagel that he was too busy to do original work. This is partly true, but not the whole truth; on one side there were diffidence, some lack of the fighting spirit, and, perhaps, a fear lest the road he chose to pursue might lead nowhere; on the other, there were his keen delight in and critical appreciation of many lines of work, and the consciousness that his life would be more complete in unselfish devotion to others than in seeking fame for himself. Such being his nature, he was inevitably drawn into administrative work, and perhaps he found himself most completely as chairman of the board of the Faculty of Natural Science. In this position his wide knowledge, sound judgment, and kindly tact were invaluable, and it was largely under his guidance that the Department of Forestry was successfully instituted in the University.

As a delegate for local examinations and for the inspection and examination of schools Nagel exerted great influence on the study of science in schools, and his judgment and experience of school work have been largely utilised by the Board of Education.

To old Trinity men Nagel had become almost an institution; his pupils scarcely regarded him as a "don," for there was a wonderful *camaraderie* between them and their tutor. But they all came to him for help and counsel. His friends and colleagues did likewise, and we are all the poorer for his loss. H. B. Dixon.

Dr. Adolf Berberich, who was on the staff of the *Berliner Jahrbuch* for thirty-five years, and for some time its director, died at Berlin last April after a long illness. Berberich was born in Baden in 1861; his family was for many years in serious financial difficulties; nevertheless, he secured a good education, first at the Gymnasium at Rastatt, then at Strassburg University, where he studied astronomy under Winnecke and Schur. He suffered from extreme short-sight, which made astronomical observing difficult, so he turned his energies to the computational side of the science, in which he showed such energy and skill that his name was already known as an orbit computer in 1884, in which year he obtained a post on the staff of the Rechen-Institut. Berberich was soon led to take a special interest in reducing the computation of orbits and ephemerides of the minor planets to an orderly system, his work being invaluable in identifying and following the immense number of new planets that were discovered by photography. He was on terms of intimate friendship with Prof. Max Wolf and Dr. Johann Palisa, who were indefatigable on the observational side; he frequently received the observed places of a new planet at breakfast, and sent back its orbit and ephemeris before lunch. He had a marvellous memory, enabling him to keep the elements of many planets in his head, thus greatly facilitating their identification. The task of keeping the immense array of planets under sufficient observation is a Herculean one, only to be accomplished by systematic division of labour. International arrangements had been made in this direction before the war, largely under the initiative of the Rechen-Institut. Unfortunately, unnecessary duplication of work now prevails again. Berberich was much esteemed by a wide circle of friends as an earnest, religious, and benevolent man. He married not long before his death, and his wife survives him. An appreciation of his work by Prof. F. Cohn is contained in *Astronomische Nachrichten*, No. 5053.

The death is announced, at the age of fifty-eight, of Prof. Samuel Sheldon, professor of physics and electrical engineering at the Polytechnic Institute of Brooklyn since 1889. Prof. Sheldon was at one time assistant to Kohlrausch, with whom he was associated in the former's determination of the ohm. In 1906 he was elected president of the American Institute of Electrical Engineers.

The death of Sir Lindsay Wood, Bt., on September 22, at eighty-six years of age, is announced in the Journal of the Royal Society of Arts. Sir Lindsay was born in 1834, and educated at the Royal Kepier Grammar School, Houghton-le-Spring, and King's College, London. He served as a mining engineer apprentice at Hetton Collieries, of which in 1866 he became managing director. He was also on the boards of several other coal companies and allied undertakings. From 1875–78 he was president of the Northern Institute of Mining and Mechanical Engineers, and in 1879 he served on the Royal Commission on Accidents in Mines. His chief work was a series of elaborate and exhaustive experiments on the pressure of gas in coal. Sir Lindsay was created a baronet in 1897, and served as Deputy-Lieutenant and High Sheriff of the County of Durham.

Dr. Harmon Northrup Morse, professor of inorganic and analytical chemistry and director of the chemical laboratory at Johns Hopkins University, died recently in his seventy-second year. Having graduated at Amherst in 1873, Dr. Morse returned to that college as an assistant in chemistry in 1875, after a period of study at Göttingen. In the following year he was appointed associate professor at Johns Hopkins, and in 1891 was promoted to a full professorship. He carried out many original researches on osmotic pressure and related subjects.

Notes.

At the concluding meeting of the International Congress of Physiologists, which was held in Paris on July 16–20, it was unanimously resolved, on the invitation of Sir E. Sharpey Schafer, to hold the next meeting in Edinburgh in 1923.

The annual oration of the Medical Society of London is to be delivered in May next by Lord Dawson of Penn. The Lettsomian lectures of the same society are to be given in February and March next by Mr. George E. Gask.

The British Electrical and Allied Industries Research Association has been approved by the Department of Scientific and Industrial Research as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. The association may be approached through Mr. E. B. Wedmore, Electrical Research Committee, c/o Electrical Development Association, Hampden House, 64 Kingsway, W.C.2.

The following arrangements have been made by the Royal College of Physicians of London:—The Horace Dobell lecture will be delivered by Sir William B. Leishman, at 5 o'clock on November 2, on "An Experimental Investigation of the Parasite of Tick Fever, *Spirochaeta Duttoni*"; the Bradshaw lecture by Dr. C. Wall, at 5 o'clock on November 4, on "Chorea"; and the FitzPatrick lectures by Dr. E. G. Browne, at 5 o'clock on November 9 and 11, on "Arabian Medicine after Avicenna."

The council of the Chemical Society has arranged for the following lectures to be held during the coming session:—October 28, Emil Fischer memorial lecture, Dr. M. O. Forster; December 16, Some Properties of Explosives,' Sir Robert Robertson; April 7, 1921, Mass Spectra and Atomic Weights, Dr. F. W. Aston; and June 16, 1921, The Natural Photosynthetic Processes on Land and in Sea and Air, and their Relation to the Origin and Preservation of Life upon the Earth, Prof. Benjamin Moore. By the courtesy of the council of the Institution of Mechanical Engineers, the first two lectures will be held in the lecture hall of that institution (Storey's Gate, Westminster, S.W.1). Informal meetings, at which fellows are invited to show experiments and apparatus, will be held at Burlington House on November 18 next and on February 3 and May 19, 1921.

Prof. F. Soddy's review of the activities of the Department of Scientific and Industrial Research published in the *Observer* of September 26 has been followed up in the same newspaper by letters from Dr. J. W. Evans and Mr. J. W. McConnell. Prof. Soddy remarked: "To-day a new kind of science—Government science—is being step by step built up, not for humanity, but its masters; not for the community, but big business"; emphasised the fundamental change of policy which accompanied the creation of the new department for the administration of funds for industrial research; and contrasted the generous treatment and comparative freedom from Government control accorded to industrial associations with the arbitrary methods of dealing with individual research workers. Dr. Evans suggests that the mistakes of the Department are attributable to the "fundamentally wrong-headed attitude adopted by the nation generally with regard to our scientific societies and the science faculties of our universities," and instances the disabilities under which these bodies suffer in carrying on their work. He deplores also the decision of some university authorities to raise their fees at a critical time in the nation's history. Mr. McConnell, who acted as chairman of the provisional committee for forming the Cotton Research Association, although in general sympathy with the views expressed by Prof. Soddy, is of the opinion, which is not shared, however, by scientific workers generally, that "the rewards of the research of whatever kind should have been primarily secured to those who found the money to pay for it."

The wonderful achievements of Rolf, the thinking Airedale terrier, bid fair to be eclipsed by the marvel of his daughter Lola. Lola passed at the age of two years into the keeping of Miss Kindermann when she could only say "yes" and "no," but after a few days of schooling the dog could read and count. In one day's lesson she could tell the hour by the clock. In the same way she acquired a knowledge of days, months, measurements, and musical notes, could forecast the weather, and gave evidence of "filosofia morale." Dr. W. Mackenzie, from whose "Gli Animali 'Pensanti'" (*Quaderni di Psichiatria*, 1920) these particulars are taken, vouches for Miss Kindermann's ability, veracity, love of animals, and ignorance of psychology. He does not attribute all the intelligence to Lola, but believes that there is a *rapporto medianico* between the supra-liminal consciousness of mistress and the sub-liminal unconsciousness of pupil. Seeing, however, that Dr. Neumann's experiments (duly discussed in the pamphlet) place Rolf's achievements in a new light, it may be well to await further observations on Lola before passing judgment on Dr. Mackenzie's conclusions. The trouble is that negative results may be explained as due to lack of the said *rapporto*.

The study of place-names, of great importance in American geography, has been much advanced by a monograph entitled "Yurok Geography," by Mr. T. T. Waterman, published in the series of publications of the University of California, vol. xvi., No. 5. This summarises a great mass of material collected by Dr. A. L. Kroeber and the writer among the Yurok Indians along the Klamath River and in the adjacent region of north-western California. Many of these primitive Indian names are now used by white settlers, and appear in the ordinary maps of this region in anglicised form. Their identification and interpretation naturally present much difficulty, but the present monograph, with its careful lists and maps, will be of interest to both the geographer and the philologist.

The system of geomancy or divination known as Raml, "sand," is common among the Arabs. At a propitious hour, noon, or one-third of the day before or after noon, the Khattāt, or "writer," prepares a smooth patch of sand, while his client places the tip of the middle finger of his right hand on the ground and states mentally the object of his quest. Then the diviner makes finger-prints at random in the sand and counts off the prints of each line in pairs to see if it contains an odd or an even number. There are, on the whole, sixteen possible figures in the diagrams which he makes, each of which has its special name and meaning. The nomad Arab in the Sudan, says Mr. R. Davies, who gives a full account of the system (*Sudan Notes and Records*, vol. iii., No. 2), spends much of his time in search of lost or stolen animals, and this system of divination has thus arisen. It seems to be successful, for Mr. Davies writes: "On the only occasions, three in number, when serious trial of the Khatt has been made in the presence of the writer, the forecast of the Khattāt has each time been justified by the result."

In an elaborate monograph (University of California Publications in American Archæology and Ethnology, vol. xvii., No. 1) Mr. Paul Radin discusses the sources and authenticity of the history of the ancient Mexicans. These sources, which are of great extent, fall into two types: the actual old Indian codices, of which there are but a few extant, and the works of Christianised Indians and Spaniards. The vast majority of the old manuscripts have disappeared, as well as the copies made of them. As late, however, as 1746 Boturini was able to make a large collection dealing with all the aspects of the ancient culture. Mr. Radin in this monograph has made a critical study of a large number of ancient documents, and provides English translations of the most important passages. The value of some of these materials is doubtful, but the Nahua peoples had a complex calendar system and a rude system of writing, and as they were deeply interested in the traditions of their migrations, it seems clear that these records contain information of much value to ethnologists. Mr. Radin has done good service to science in his careful account of these manuscripts and by his translations of the most important records.

During the Mahdist occupation of the Sudan (1885–98) coins were struck by the Mahdi at Khartum, and later by the Khalifa at Omdurman. Many of these coins have now become scarce, and Mr. H. S. Job, in *Sudan Notes and Records* (vol. iii., No. 3), has done good service to numismatics by giving a full account of this example of the debasement of currency in the hands of a despotic ruler, and by providing a full catalogue, with illustrations, of the various types of mintage. After the fall of Khartum in 1885 considerable treasure of Egyptian and English gold coins, the Mejidi and Maria Theresa dollars, with smaller Egyptian coins, fell into the hands of the Mahdi, who determined to have the bullion melted down and recoined. It was decided that two coins should be struck, a gold pound and a silver dollar, to which later a half-dollar was added. For the first the Egyptian gold piece of 100 piastres of Sultan Abd-al-Mejid was taken as the model, the name of the Sultan being replaced by the words "By Order of the Mahdi." Though these coins were of good quality they were regarded with mistrust, and circulated at less than their par value, while many foreign coins, though much worn, remained in circulation. It may be hoped that a full series of these interesting coins has been provided in our museums.

In a detailed analysis of the inheritance of hoariness in stocks, Miss Saunders (*Journ. Genetics*, vol. x., No. 2) shows that a graded series from the fully hoary form *incana* to the completely glabrous form can be obtained. Historical records indicate that the extreme glabrous form was probably the first to arise from *incana*, being mentioned as early as

1588, while Linnæus mentions the rare half-hoary *semi-incana* in 1762. Crosses of these forms produce a series of intermediate factorial combinations, including a type with a single hair on the tip of each leaf. It is concluded that the "factor" for a particular degree of hairiness represents a particular condition of physiological equilibrium subject to environmentally produced fluctuations.

In the Journal of the Royal Microscopical Society (1920, part 2) Mr. T. E. Wallis describes a method of quantitative microscopy by use of Lycopodium spores. By a sufficiently thorough mixing of the materials to be tested with the spores and by the use of a suitable suspending medium, the author finds it possible, by making a number of counts of the spores in different fields of view, to obtain results of an order of accuracy equal to many of those obtained by chemical operations both qualitative and quantitative. As examples are cited the determination of the proportion of maize-starch that had been added to some ordinary wheat-flour, and the determination of the number both of starch grains per milligram of maize-starch and of pollen-grains per milligram of insect-powder; the last-mentioned supplies an index of the value of the powder.

Dr. W. Mackie has shown that monazite is widely distributed in the granites of the North of Scotland, and it has now been found by Dr. A. Gilligan in almost all the beds of the Millstone Grit of Yorkshire, doubtless derived from this northern source ("The Petrography of the Millstone Grit of Yorkshire," Quart. Journ. Geol. Soc., vol. lxxv., p. 271, 1920).

The "Final Report of the Work of the Commission on Munition Resources, Canada" (Toronto, 1920), besides useful notes on recent prospecting, contains (pp. 58–88) an account of trenches made for the investigation of bog-manganese ore, which may be of service to those interested in such deposits in Ireland. There seems not much hope of competition between the bog material and the hard ores of the ordinary mines. We have yet to learn how far selective action by bacteria is responsible for the precipitation of manganese oxides in swamps. Mr. Uglow's practical report naturally leaves the matter open.

Dr. R. S. Lull describes in the *American Journal of Science* (vol. l., p. 83, 1920) two "new Tertiary Artiodactyls" from remains discovered in Nebraska in 1914 by an expedition from Yale under his guidance. The deposits are of Late Miocene or Early Pliocene age. A very pleasing restoration is given of a new antelope, *Aletomeryx gracilis*, of which abundant material has been obtained, including nineteen skulls, both male and female. The name, meaning "wandering ruminant," is chosen on account of the migratory powers indicated by the delicacy of the limbs. The limb-bones are, indeed, generally broken.

From the General Report of the Survey of India for 1918–19 we learn that the curtailment of work owing to war conditions continued, several survey parties being engaged in Mesopotamia, East Africa, and elsewhere out of India. Of the topographical map on the one-inch scale 57 sheets were published during the year in place of the pre-war figure of 150 to 200. About 1500 one-inch sheets have now been published out of a total of 6218. Thirty half-inch and 11 quarter-inch, or "degree," sheets were published. The half-inch map is now the tactical map of India, and 177 of the 630 sheets are available. The "degree" sheets are making slower progress, and their total is now only 52 out of 450. No further sheets of La Carte Internationale (1 : 1,000,000) appeared during the year, but two sheets of the India and Adjacent Countries Series (1 : 1,000,000) were published. The report includes complete indices of all sheets published by the Survey of India.

The Mines Branch of the Department of Mines of Canada has just issued a valuable monograph on graphite, written by Mr. Hugh S. Spence. It describes in detail the important Canadian occurrences of this mineral, and also reviews all other known sources of supply throughout the world. It is interesting to note that in 1913 Germany and Austria together produced practically one-half of the world's total supply, but that since then the American output has been nearly trebled. An interesting account is given of the various methods used for the concentration of graphite, for which purpose the flotation process appears now to be the most favoured, and the manufacture of artificial graphite is also described. An important section is devoted to the industrial applications of graphite; it is stated that the world's production of natural graphite is utilised in approximately the following proportions: For crucibles, 75 per cent.; for lubricants, 10 per cent.; for pencils, 7 per cent.; for foundry facing and stove-polish, 5 per cent.; and for paints, 3 per cent. The method of manufacture of all these articles is described, as well as that of others not included in the above list, such as graphite brushes for dynamos and motors, graphite electrodes, graphite for dry batteries, for electrotyping, and for various less important purposes. The monograph should prove valuable to all interested in the mining of graphite or the manufacture of graphite articles.

The United States Geological Survey has just issued an elaborate monograph on the economic geology of Gilpin County and adjacent parts of Clear Creek and Boulder Counties, Colorado, by Mr. E. S. Bastin and Mr. J. M. Hill. This district includes most of the mining camps of Colorado that are producing minerals of economic importance, including the well-known auriferous pyritic ores of Gilpin County, the gold and silver veins of Clear Creek County, the lead ores of Leadville, the telluric gold ores of Telluride, and many others. In addition to gold, silver and lead ores, the district here described produces also ores of zinc, copper, uranium and tungsten, the gold production being, however, economically by far the most important. The monograph describes the general topography of the area, spoken of here as the Central City quadrangle; the geology is described in detail, particular attention being devoted to the igneous rocks, amongst which the monzonites are the most important. Chapters are devoted to the economic geology and to the general features and origin of the various ore deposits, each of the more important ores being discussed separately. An interesting chapter is devoted to the methods of ore-treatment, the history of the development of the so-called Colorado or Gilpin County method of gold-milling being clearly traced, as also its displacement by the more recent processes of cyanidation and flotation. Justice is also done to the development of the smelting process, under Mr. R. Pearce, from its small beginnings at Blackhawk, removed afterwards to Argo, close to Denver. Statistical tables of the output are given, showing the economic importance of this district. The remainder of the book is taken up with a detailed description of all the mines of importance, the geological relationships of the ore-bodies being worked out in much detail.

THE Journal of the College of Science of the Imperial University of Tokyo for May 10 last contains an important paper, of interest to the students of the genesis of mineral deposits, under the title of "A Contribution to the Knowledge of the Cassiterite Veins of Pneumato-Hydatogenetic or Hydrothermal Origin: A Study of the Copper-Tin Veins of the Akénobé District in the Province of Tajima, Japan," by Takeo Katō. The district in question contains a system of practically parallel veins worked at first for copper, but afterwards found to contain important proportions of tinstone and wolframite. The author holds that "the veins of the Akénobé district are all consanguineous, and all gradations exist between the copper veins containing little or no cassiterite and the copper-tin veins containing much of the same mineral." The veins occur chiefly in Palæozoic slates. The abnormal feature of the occurrence is the fact that the district shows important exposures of intrusive dioritic rocks, forming either large masses or offshoots from these. There are, it is true, dykes of andesites and porphyrites, but these cut the veins "and are clearly later in generation than the latter." "No granitic or allied acid plutonic rocks have been observed," and the author concludes definitely that the veins are related genetically to the dioritic rocks—an occurrence which, though common enough so far as copper-bearing veins are concerned, is probably unique in respect of tin veins. The author's summary of the genesis of these veins is as follows: "The copper-tin veins of the Akénobé district were deposited from hydrothermal solutions, still containing fair quantities of mineralisers, at gradually decreasing temperatures, chiefly considerably below 360° C. The solutions had naturally a temperature far above the critical point of water (364° C.), and were gaseous in character, after emanation from the consolidating diorite magma. As they ascended through the surrounding slate complex the rate of fall of the temperature was very rapid, and they soon changed to superheated hydrothermal solutions."

THE chief periods of seismic activity of the well-known Comrie centre are from 1788 to 1801 and from 1839 to 1844. Since the latter year very few shocks have been felt. Some are recorded from time to time in Perrey's annual catalogues. During the last thirty years five have been felt, all of them slight and disturbing an area of at most a few square miles. Three of these occurred towards the close of last century —on July 12, 1894, July 12, 1895, and August 22, 1898. In the present year a slight increase of activity is shown by the occurrence of a shock of intensity 3 (Rossi-Forel scale) on July 21, and of a slightly stronger shock (intensity 4) on September 14.

CANADA is keeping well abreast of the times in meteorology, and its Monthly Record of meteorological observations, which includes data from the Colonies of Bermuda and Newfoundland, will add much of value to the general knowledge of the world's weather. Results for the early months of the present year are to hand. Tables and maps are given showing the monthly average temperature and precipitation, together with differences from the normal over the whole Dominion. The observations are classified for province and district. For many places temperature, atmospheric pressure, and humidity are given for each hour, and the mean monthly averages and totals are well set out, also the mean proportion of bright sunshine for each hour that the sun is above the horizon. Observations of wind direction and velocity and of cloudiness are also obtainable. The detailed observations of wind both from the first- and second-class stations will prove of much value to the aeronaut. No observations are made at present of the form of cloud, or of the direction and speed of either lower or upper clouds. Such observations would be useful in the elucidation of upper-air problems.

AN analysis of the rate of ascent of pilot-balloons has been made by Lieut. R. P. Batty, and is published by the Meteorological Office as Professional Notes No. 12. The observations were taken at Butler's Cross, Salisbury Plain, from June to December, 1919. The ascents were not made at fixed hours of the day, but when required by the School of Artillery; 75 per cent. of the ascents were between 9h. and 13h. G.M.T., and mostly during July, August, and September. Average rates of ascent are given for each of the first thirteen minutes. From 225 ascents 1464 minute readings were obtained, and the mean rate of all ascents is 530 ft. per minute. Ascents have been grouped for specified hours of the day, and the mean rate is shown to be greatest at about mid-day. Ascents are also classified according to the amount of cloud in the sky, and it is seen that more cloud gives an increased rate of ascent. Moderate and strong winds give a higher rate of ascent than light winds, and the rate of ascent for different wind directions is also classified. It is noticed that immediately prior to entering cloud the rate of ascent almost invariably increases, mostly to 600–700 ft. per minute. Rain is said to decrease the rate of ascent by about 20 per cent. The size of the pilot-balloons used was 70 in. or 90 in., and their weight varied from 20 to 30 grams. Tables and diagrams are given showing the variations under the different classifications.

FATHER FROC has added yet another contribution to his already valuable researches on the typhoons of the Far East, in the "Zi-Ka-Wei Observatory Atlas of the Tracks of 620 Typhoons, 1893–1918." The atlas contains a series of charts showing the actual tracks of the centres of 620 typhoons which have been reported in the Far East during the twenty-six years, 1893–1918. The original purpose of the author was to issue these charts as an appendix to a more general study of the subject, but since the publication of this more comprehensive report has been considerably delayed, it was decided that the appendix should appear at once. Consequently, the atlas contains little more than the charts themselves, with brief explanatory notes on each. It lays no claim to be a theoretical treatise on the structure and origin of these revolving storms. No attempt at classification is made, since the charts are intended solely for the nautical guidance of sailors. The cases are enumerated month by month as they occur, and to avoid confusion and overlapping of the tracks, three charts are allotted to each of the months of maximum frequency (July to October inclusive). The maps cover a wide geographical area, from Cochin China and the Philippines in the south, to Manchuria and the Kurile Islands in the north, while embracing a vast stretch of the Pacific eastwards from the Asiatic mainland to 150° E. longitude. The irregular west-south-westerly motion of occasional storms in this region—chiefly in the China Sea—is clearly shown in the charts, and the author lays stress on the point that navigators should be familiar with the possibility of this unusual movement, even though the vast majority of the storms follow a general north-westerly track, such as is customary in the northern hemisphere. In conclusion, twelve summary maps are given, showing the dangerous zones and the successive changes which take place throughout the year. The atlas is of additional value in that it gives a trustworthy and up-to-date measure of typhoon frequency.

WE have received a copy of Catalogue No. 23 of second-hand books in science just issued by Mr. R. S. Frampton, 37 Fonthill Road, Finsbury Park, N.4. The works listed (some 1100 odd) range over most of the sciences, and the prices asked are very reasonable. The catalogue will be sent free upon application.

DR. WALTER KIDD is publishing through Messrs. H. F. and G. Witherby a work entitled "Initiative in Evolution," which will contribute to the evidence in favour of Neo-Lamarckism, and give especial consideration to the arrangement of the hair in mammals. Messrs. Witherby also give notice of "A Naturalist in Himalaya," by Capt. R. W. G. Hingston, in which attention is given, among other subjects, to geometrical spiders and their work, various species of ants and their organisations, and the nesting instincts of birds.

THE reviewer of "Smithsonian Meteorological Tables" in NATURE of September 30, p. 142, stated that the Tables are not obtainable in the ordinary way. Messrs. W. Wesley and Son, 28 Essex Street, Strand, W.C.2, remind us, however, that they are the agents for the Smithsonian Institution in London, and that the Tables can be purchased from them. The Tables form vol. lxix. of the Smithsonian Miscellaneous Collections, and not vol. lix., as given at the head of the review.

Our Astronomical Column.

PROF. PICKERING'S LUNAR OBSERVATIONS.—Prof. W. H. Pickering has for many years been making a careful study of certain lunar formations under all angles of illumination, finding striking changes of relative luminosity of adjacent markings in the course of the lunar day, which he ascribes to the presence of snow or hoar-frost, or in some cases to vegetation. There can be only one opinion as to the interest and value of the observations, whether Prof. Pickering's conclusions are accepted or not. His latest study (*Popular Astronomy*, August and September) is of the region round the crater Conon in the Apennines and the neighbouring formation of Bradley. He asserts that this region contains snowfields, clouds, and tracts covered with vegetation. He distinguishes the clouds from the snowfields as being more yellowish, less brilliant, and more subject to change. One note that he makes about them would seem to throw some doubt on their assumed nature. "No clear evidence of motion due to wind has ever been seen in the lunar clouds, which apparently merely form and dissolve *in situ*." The white snow-patches, on the other hand, which appear hazy at sunrise, are stated to show some drift; the "vegetation" regions darken conspicuously as the sun rises higher upon them. The author asserts that volcanic activity is by no means extinct on the moon, the floor of Plato being stated to be an active region emitting many steam-jets.

There cannot be much doubt about the relative change of brightness of the different markings, but it does not appear that the author has given enough consideration to the possibility that it may arise from differences in the composition of the rocks or of their degree of slope and of smoothness. While the occurrence of snow, cloud, and vegetation cannot be ruled out as impossible, it is at least somewhat difficult to reconcile with the tenuity of atmosphere that is demonstrated by the practical absence of refraction in occultations and eclipses.

THE SUN'S MAGNETIC FIELD.—The *Observatory* for September contains an article by Dr. F. H. Seares, written at Prof. Hale's request, giving an account of the researches made at Mount Wilson since 1908 on the sun's magnetic field. The investigation was suggested by the discovery of the Zeeman effect in the spectra of sun-spots, which were surrounded by hydrogen vortices. In the case of the general field the spectral shifts are extremely minute, less than one-thousandth of an angstrom, and it is only the remarkable accordance in the results that gives confidence that the effect is a real one, the shifts being of the same order as accidental errors in the measures. The precaution was taken that the measurer should not know in which direction the shift on any plate was likely to be, so that all bias was eliminated. Comparatively few of the spectral lines were found to be suitable for the research, and the results depend chiefly on iron and chromium lines. A first solution showed that the northern hemisphere had negative polarity, and that the magnetic axis was close to the rotational one. It was afterwards found that the inclination of axes is about 6°, and that the magnetic axis revolves about the other in 31·44 days. The investigation indicates that the field strength diminishes rapidly with increasing elevation, falling from 50 to 10 gausses in 200 km. It will be noted that the shifts in this investigation are much smaller than in the Einstein spectral test; but differential measures suffice here, while in the other case absolute ones are required.

Fossils and Life.*

By F. A. BATHER, M.A., D.Sc., F.R.S.

II.

THE argument for orthogenesis based on a race-history that marches to inevitable destruction, heedless of environmental factors, has always seemed to me incontrovertible, and so long as my knowledge of palæontology was derived mainly from books I accepted this premise as well-founded. But more intensive study generally shows that characters at first regarded as indifferent or detrimental may have been adapted to some factor in the environment or some peculiar mode of life.

Prof. Duerden's studies of the ostrich lead him to the opinion that retrogressive changes in that bird are destined to continue, and "we may look forward," he says, "to the sad spectacle of a wingless, legless, and featherless ostrich if extinction does not supervene." Were this so, we might at least console ourselves with the thought that the process is a very slow one, for Dr. Andrews tells me that the feet and other known bones of a Pliocene ostrich are scarcely distinguishable from those of the present species. But, after careful examination of Prof. Duerden's arguments, I see no ground for supposing that the changes are other than adaptive. Similar changes occur in other birds of other stocks when subjected to the requisite conditions, as the flightless birds of diverse origin found on ocean islands, the flightless and running rails, geese, and other races of New Zealand, and the Pleistocene Genyornis of the dried Lake Callabonna, which, as desert conditions came on, began to show a reduction of the inner toe. Among mammals the legs and feet have been modified in the same way in at least three distinct orders or sub-orders during different periods and in widely separated regions. [The instances were given.]

In all these cases the correlation of foot-structure with mode of life (as also indicated by the teeth) is such that adaptation by selection has always been regarded as the sole effective cause.

My colleague, Dr. W. D. Lang, has recently published a most thoughtful paper on this subject. His profound studies on certain lineages of Cretaceous Polyzoa have led him to believe that the habit of secreting calcium carbonate, when once adopted, persists in an increasing degree. Thus in lineage after lineage the habit "has led to a brilliant, but comparatively brief, career of skeleton-building, and has doomed the organism finally to evolve but the architecture of its tomb." These creatures, like all others which secrete calcium carbonate, are simply suffering from a gouty diathesis, to which each race will eventually succumb. Meanwhile, the organism does its best to dispose of the secretion; if usefully, so much the better, but, at any rate, where it will be least in the way. Some primitive Polyzoa, we are told, often sealed themselves up; others escaped this self-immurement by turning the excess into spines, which in yet other forms fused into a front wall. But the most successful architects were overwhelmed at last by superabundance of building material.

While sympathetic to Dr. Lang's diagnosis of the disease, still I think he goes too far in postulating an "insistent tendency." He speaks of living matter as if it were the over-pumped inner tube of a bicycle tyre, "tense with potentiality, curbed by inhibitions" [of the cover], and "periodically breaking out as inhibitions are removed" [by broken glass]. A race acquires the lime habit or the drink habit, and, casting off all restraint, rushes with accelerated velocity down the easy slope to perdition.

A melancholy picture! But is it true? The facts in the case of the Cretaceous Polyzoa are not disputed, but they can be interpreted as a reaction of the organism to the continued abundance of lime-salts in the sea-water. If a race became choked off with lime, this perhaps was because it could not keep pace with its environment. Instead of "irresistible momentum" from within we may speak of irresistible pressure from without. Dr. Lang has told us "that in their evolution the individual characters in a lineage are largely independent of one another." It is this independence, manifested in differing trends and differing rates of change, that originates genera and species. Did the evolution follow some inner impulse, along lines "predetermined and limited by innate causes," one would expect greater similarity, if not identity, of pattern and of *tempo*.

Many are the races which, seeking only ornament, have (say our historians) perished like Tarpeia beneath the weight of a less welcome gift: oysters, ammonites, hippurites, crinoids, and corals. But I see no reason to suppose that these creatures were ill-adapted to their environment—until the situation changed. This is but a special case of increase in size. In creatures of the land probably, and in creatures of the water certainly, size depends on the amount of food, including all body- and skeleton-building constituents. When food is plentiful larger animals have an advantage over smaller. Thus by natural selection the race increases in size until a balance is reached. Then a fall in the food-supply handicaps the larger creatures, which may become extinct. So simple an explanation renders it quite unnecessary to regard size as in itself indicating the old age of the race.

Among the structures that have been most frequently assigned to some blind growth-force are spines or horns, and when they assume a grotesque form or disproportionate size they are dismissed as evidences of senility. Let us take the case of certain spiny trilobites. Strange though these little monsters may be, I cannot, in view of their considerable abundance, believe that their specialisation was of no use. Such spines have their first origin in the tubercles which form so common an ornament in Crustacea and other Arthropods, and which serve to stiffen the carapace. A very slight projection of any of these tubercles further acts as a protection against such soft-bodied enemies as jelly-fish. Longer outgrowths enlarge the body of the tribolite in such a way as to prevent it being easily swallowed. When, as is often the case, the spines stretch over such organs as the eyes, their protective function is obvious. This becomes still more clear when we consider the relation of these spines to the body when rolled up, for then they are seen to form an encircling or enveloping *chevaux-de-frise*. But, besides this, the spines in many cases serve as balancers; they throw the centre of gravity back from the weighty head, and thus enable the creature to rise into a swimming posture. Further, by their friction they help to keep the animal suspended in still water with a comparatively slight motion of its numerous oar-like limbs. Regarded in

* Opening address of the President of Section C (Geology), delivered at the Cardiff Meeting of the British Association on August 24. Greatly abridged. Only the larger excisions are indicated by asterisks. Continued from p. 164.

this light, even the most extravagant spines lose their mystery and appear as consequences of natural selection.

The fact that many extreme developments are followed by the extinction of the race is due to the difficulty that any specialised organism or machine finds in adapting itself to new conditions. A highly specialised creature is one adapted to quite peculiar circumstances; very slight external change may put it out of harmony, especially if the change be sudden. It is not necessary to imagine any decline of vital force or exhaustion of potentiality.

What, then, is the meaning of "momentum" in evolution? Simply this: that change, whatever its cause, must be a change of something that already exists. The changes in evolving lineages are, as a rule, orderly and continuous. Environment changes slowly and the response of the organism always lags behind it, taking small heed of ephemeral variations. Suppose a change from shallow to deep water—either by sinking of the sea-floor or by migration of the organism. Creatures already capable of becoming acclimatised will be the majority of survivors, and among them those which change most rapidly will soon dominate. Place your successive forms in order, and you will get the appearance of momentum; but the reality is inertia yielding with more or less rapidity to an outer force.

* * *

But in all these apparent instances we should do well to realise that we are still incompletely informed about the daily life of these creatures and of their ancestors in all stages of growth, and we may remember that structures once adaptive often persist after the need has passed or has been replaced by one acting in a different direction.

The Study of Adaptive Form.

This leads us on to consider the influence of the mode of life on the shape of the creature, or, briefly, of function on form; and, conversely, the indications that form can give as to habits and habitat. For many a long year the relatively simple mechanics of the vertebrate skeleton have been studied by palæontologists and anatomists generally, and have been brought into discussions on the effect of use. These studies, however, have usually considered the structure of an animal as an isolated machine. We have to realise that an organism should be studied in relation to the whole of its environment, and here form comes in as distinct from structure. Similar adaptive forms are found in organisms of diverse structure, and produce those similarities which we know as "convergence." To take but one simple instance from the relations of organisms to gravity. A stalked Echinoderm naturally grows upright, like a flower, with radiate symmetry. But in the late Ordovician and in Silurian rocks are many in which the body has a curiously flattened leaf-like shape, in which the two faces are distinct but the two sides alike, and in which this effect is often enhanced by paired outgrowths corresponding in shape if not in structure. Expansion of this kind implies a position parallel to the earth's surface, *i.e.* at right angles to gravity. The leaf-like form and the balancers are adaptations to this unusual position. Recognition of this enables us to interpret the peculiar features of each genus, to separate the adaptive form from the modified structure, and to perceive that many genera outwardly similar are really of quite different origin.

Until we understand the principles governing these and other adaptations—irrespective of the systematic position of the creatures in which they appear—we cannot make adequate reconstructions of our fossils, we cannot draw correct inferences as to their mode of life, and we cannot distinguish the adaptive from the fundamental characters. No doubt many of us have long recognised the truth in a general way, and have attempted to describe our material—whether in stone or in alcohol—as living creatures; and not as isolated specimens, but as integral portions of a mobile world. It is, however, chiefly to Louis Dollo that we owe the suggestion and the example of approaching animals primarily from the side of the environment, and of studying adaptations as such. The analysis of adaptations in those cases where the stimulus can be recognised and correlated with its reaction (as in progression through different media or over different surfaces) affords sure ground for inferences concerning similar forms the life-conditions of which we are ignorant. But from such analyses there have been drawn wider conclusions pointing to further extension of the study. It was soon seen that adaptations did not come to perfection all at once, but that harmonisation was gradual, and that some species had progressed further than others. But it by no means follows that these represent chains of descent. The adaptations of all the organs must be considered and one seriation checked by another.

In applying these principles we are greatly helped by Dollo's thesis of the Irreversibility of Evolution. This is a simple statement of the facts as hitherto observed, and may be expressed thus:

(1) In the course of race-history an organism never returns exactly to its former state, even if placed in conditions of existence identical with those through which it has previously passed. Thus, if through adaptation to a new mode of life (as from walking to climbing) a race loses organs which were highly useful to it in the former state, then, if it ever reverts to that former mode of life (as from climbing to walking) those organs never return, but other organs are modified to take their place.

(2) But (continues the law), by virtue of the indestructibility of the past, the organism always preserves some trace of the intermediate stages. Thus, when a race reverts to its former state there remain the traces of those modifications which its organs underwent while it was pursuing another mode of existence.

The first statement imposes a veto on any speculations as to descent that involve the reappearance of a vanished structure. The second statement furnishes a guide to the mode of life of the immediate ancestors, and is applicable to living as well as to fossil forms. It is from such persistent adaptive characters that some have inferred the arboreal nature of our own ancestors, or even of the ancestors of all mammals.

The Study of Habitat.

The natural history of marine invertebrata is of particular interest to the geologist, but its study presents peculiar difficulties. The marine zoologist has long recognised that his early efforts with trawl and dredge threw little light on the depth in the sea frequented by his captures. The surface floaters, the swimmers of the middle and lower depths, and the crawlers on the bottom were confused in a single haul, and he has therefore devised means for exploring each region separately. The geologist, however, finds all these faunas mixed in a single deposit. He may even find with them the winged creatures of the air, as in the insect beds of Gurnet Bay, or the remains of estuarine and land animals.

The Upper Ordovician starfish bed of Girvan contains not only the crawling and wriggling creatures from which it takes its name, but also stalked echinoderms adapted to most varied modes of life, swimming and creeping trilobites, and, indeed, representatives of almost all marine levels.

In the study of such assemblages we have to distinguish between the places of birth, of life, of death, and of burial, since, though these may be all the same, they may also all be different. The echinoderms of the starfish bed further suggest that closer discrimination is needed between the diverse habitats of bottom forms. Some of these were, I believe, attached to seaweed; others grew up on stalks above the bottom; others clung to shells or stones; others lay on the top of the sea-floor; others were partly buried beneath its muddy sand; others may have grovelled beneath it, connected with the overlying water by passages. Here we shall be greatly helped by the investigations of C. G. J. Petersen and his fellow-workers of the Danish Biological Station. They have set an example of intensive study which needs to be followed elsewhere. By bringing up slabs of the actual bottom they have shown that, even in a small area, many diverse habitats, each with its peculiar fauna, may be found, one superimposed on the other. Thanks to Petersen and similar investigators, exact comparison can now take the place of ingenious speculation. And that this research is not merely fascinating in itself, but illuminatory of wider questions, follows from the consideration that analysis of faunas and their modes of life must be a necessary preliminary to the study of migrations and geographical distribution.

The Tempo of Evolution.

We have not yet done with the results that may flow from an analysis of adaptations. Among the many facts which, when considered from the side of animal structure alone, lead to transcendental theories with Greek names, there is the observation that the relative rate of evolution is very different in races living at the same time. Since their remains are found often side by side, it is assumed that they were subject to the same conditions, and that the differences of speed must be due to a difference of internal motive force. After what has just been said, you will at once detect the fallacy in this assumption. Prof. Abel has recently maintained that the varying *tempo* of evolution depends on the changes in outer conditions. He compares the evolution of whales, sirenians, and horses during the Tertiary epoch, and correlates it with the nature of the food.

* * *

Whether such changes of food or of other habits of life are, in a sense, spontaneous, or whether they are forced on the creatures by changes of climate and other conditions, makes no difference to the facts that the changes of form are a reaction to the stimuli of the outer world, and that the rate of evolution depends on those outer changes.

Whether we have to deal with similar changes of form taking place at different times or in different places, or with diverse changes affecting the same or similar stocks at the same time and place, we can see the possibility that all are adaptations to a changing environment. There is, then, reason for thinking that ignorance alone leads us to assume some inexplicable force urging the races this way or that, to so-called advance or to apparent degeneration, to life or to death.

The Rhythm of Life.

The comparison of the life of a lineage to that of an individual is, up to a point, true and illuminating; but when a lineage first starts on its independent course (which really means that some individuals of a pre-existing stock enter a new field), then I see no reason to predict that it will necessarily pass through periods of youth, maturity, and old age, that it will increase to an acme of numbers, of variety, or of specialisation, and then decline through a second childhood to ultimate extinction. Still less can we say that, as the individuals of a species have their allotted span of time, long or short, so the species or the lineage has its predestined term. The exceptions to those assertions are indeed recognised by the supporters of such views, and they are explained in terms of rejuvenescence, rhythmic cycles, or a grand despairing outburst before death. This phraseology is delightful as metaphor, and the conceptions have had their value in promoting search for confirmatory or contradictory evidence. But do they lead to any broad and fructifying principle? When one analyses them one is perpetually brought up against some transcendental assumption, some unknown entelechy that starts and controls the machine, but must for ever evade the methods of our science.

The facts of recurrence, of rhythm, of rise and fall, of marvellous efflorescences, of gradual decline, or of sudden disappearances, all are incontestable. But if we accept the intimate relation of organism and environment, we shall surmise that on a planet with such a geological history as ours, with its recurrence of similar physical changes, the phenomena of life must reflect the great rhythmic waves that have uplifted the mountains and lowered the deeps, no less than every smaller wave and ripple that has from age to age diversified and enlivened the face of our restless mother.

To correlate the succession of living forms with all these changes is the task of the palæontologist. To attempt it he will need the aid of every kind of biologist, every kind of geologist. But this attempt is not in its nature impossible, and each advance to the ultimate goal will, in the future as in the past, provide both geologist and biologist with new light on their particular problems. When the correlation shall have been completed, our geological systems and epochs will no longer be defined by gaps in our knowledge, but will be the true expression of the actual rhythm of evolution. Lyell's great postulate of the uniform action of Nature is still our guide, but we have ceased to confound uniformity with monotony. We return, though with a difference, to the conceptions of Cuvier, to those numerous and relatively sudden revolutions of the surface of the globe which have produced the corresponding dynasties in its succession of inhabitants.

The Future.

The work of a systematic palæontologist, especially of one dealing with rare and obscure fossils, often seems remote from the thought and practice of modern science. I have tried to show that it is not really so. But still it may appear to some to have no contact with the urgent problems of the world outside. That also is an error. Whether the views I have criticised or those I have supported are the correct ones is a matter of practical importance. If we are to accept the principle of predetermination or of blind growth-force, we must accept also a check on our efforts to improve breeds, including those of man, by any other means than crossings and elimination of unfit strains. In spite of all that we may do in this way, there remain those decadent races, whether of ostriches or human beings, which "await alike the inevitable hour." If, on the other hand, we adopt the view that the life-history of races is a response to their environment, then it follows, no doubt, that the past history of living creatures will have been determined by conditions outside their control, it follows that the idea of human progress as a biological law ceases to be tenable; but since man has the power of altering his environment and of adapting racial characters through conscious selection, it also follows that progress will not of necessity be followed by decadence; rather that, by aiming at a high mark, by deepening our knowledge of ourselves and of our world, and by controlling our energy and guiding our efforts in the light of that knowledge, we may prolong and hasten our ascent to ages and to heights as yet beyond prophetic vision.

International Catalogue of Scientific Literature.

An international conference of delegates from scientific academies to consider the future of the International Catalogue of Scientific Literature was held last week by invitation of the Royal Society of London. Sir J. J. Thomson, president of the Royal Society, took the chair. The conference was attended by delegates from Denmark (Prof. Martin Knudsen), France (Prof. A. Lacroix), Holland (Prof. G. van Rijnberk), India (Sir H. H. Hayden and Dr. S. W. Kemp), Japan (Prof. H. Nagaoka), New Zealand (Prof. A. Dendy), Norway (Dr. Rolf Laache), Queensland (Sir Edw. Parrott), South Africa (Sir T. Muir), Sweden (Baron Alströmer), Switzerland (Dr. H. Escher, Dr. Marcel Godet, and Dr. H. H. Field), United States of America (Prof. L. E. Dickson, Mr. L. C. Gunnell, Dr. S. I. Franz, and Dr. Robert M. Yerkes), Victoria (Prof. E. W. Skeats), and Western Australia (Mr. G. B. Rushton). The Royal Society was represented by three of its officers (Sir J. J. Thomson, Sir David Prain, and Mr. J. H. Jeans), together with Prof. Henry E. Armstrong, Dr. F. A. Bather, Dr. P. Chalmers Mitchell, and Sir Arthur Schuster. The Italian delegates, having been delayed in the railway journey, were unfortunately not in time to take part in the proceedings.

The conference was called to consider whether any modifications in the present Catalogue are advisable and how the difficulties created by the war can best be overcome. It is well known that the Royal Society, in its "Catalogue of Scientific Papers," has undertaken to make an index of all books and papers on scientific subjects published during the nineteenth century. Sixteen quarto volumes of this important catalogue have already appeared. Four more volumes will probably be sufficient to complete the Author Catalogue for the period 1800–1900. A corresponding Subject Catalogue is also being published.

In view of the ever-increasing number of scientific publications, the Royal Society realised that it could not continue to index the scientific literature of the whole world, but that such an undertaking should be carried out by a division of labour, each country indexing its own literature, the several catalogues so prepared being sent to a central bureau in London, where they should be combined and published in annual volumes. The "International Catalogue of Scientific Literature" was the outcome. It undertook to index scientific literature published after January 1, 1901.

More than thirty countries joined in the scheme, each agreeing to index its own scientific literature upon cards which should be sent to London for incorporation in the printed volumes. Fourteen annual issues, each of seventeen volumes, have now been published indexing the scientific literature of 1901–14. It was found that the sales and subscriptions to the volumes very nearly covered the cost of production.

It might have been predicted that a work of this kind, requiring harmony between workers of so many nationalities, could not be carried out without international jealousy and friction. Such has not proved to be the case. The greatest goodwill has existed between the various regional bureaux in the different countries and the central bureau in London.

The outbreak of war interrupted the work by restricting intercourse between the nations. The finances of the catalogue have also suffered from the loss of subscriptions from Austria, Germany, Hungary, and Russia. At the same time the cost of printing and publishing has more than doubled. It was in these circumstances that the Royal Society convened last week's conference.

The delegates, while agreeing that it is essential that scientific literature should be fully indexed in order that the results of researches in every country might be made known quickly to all, entered into a full discussion as to how this indexing should be done, and passed in review the different agencies now engaged in such work.

They came to the conclusion that, even though a change be made in the future in the method of indexing, it is imperative to continue the International Catalogue of Scientific Literature in its present form until the literature published up to the end of the year 1915, and possibly also that up to the end of the present year 1920, has been catalogued. In this way the important scientific work carried out during the war period will become available for reference at an early date and continuity in the work of indexing be maintained. This recommendation of the conference will come before the council of the Royal Society at their October meeting, and we are confident that the council will wish to give effect to the proposal if sufficient funds can be obtained.

A considerable sum of money will be required. It is estimated that the rise in salaries, wages, paper, and everything connected with printing and publishing is so great that an annual issue of the International Catalogue will now cost about 17,000*l*. In addition to the annual expenses, working capital of considerable amount will be required. The sum mentioned at the conference was, we believe, 34,000*l*., this being the cost of two annual issues.

There is here an opportunity for someone to make a generous donation in aid of science. The Royal Society cannot be expected to provide the large sums now required out of its own resources. The society has already spent much money in the preparation of the Catalogue of Scientific Papers, and has lent 7500*l*. to the International Catalogue and made a further donation of 1100*l*. from its funds. Contributions from European countries are invited, but may prove difficult to obtain owing to the adverse rates of exchange. It would be a great misfortune if a work of this importance came to an end through lack of funds. We have here a league of nations engaged in making the results of scientific inquiry widely known; every effort should be made to help this league to live through what is evidently the critical period of its existence.

The question as to the future of the Catalogue after the completion of the twentieth issue was referred to a committee of the delegates for further consideration. Amongst other questions this committee will examine how far the work of the International Catalogue can be brought into relation with the many existing agencies for the publication of abstracts of scientific papers.

In addition to the abstracts prepared by many of the scientific societies and to those published in periodical collections dealing with special subjects, there are card catalogues such as that under the charge of Dr. H. H. Field, of Zurich. It was suggested at the conference that these should be taken into account in fixing the form which the International Catalogue should take in the future.

The immediate problem, then, is to secure the indexing of the scientific literature published during the war. While this is being done, arrangements can be made for the efficient continuation of the work of cataloguing the scientific literature of the world.

The International Congress of Mathematicians.

THIS congress was opened at Strasbourg University on September 22 by the Rector, M. S. Claréty. The officers of the congress were then elected as follows:—*Honorary President:* M. Camille Jordan. *President:* M. Emile Picard. *Vice-Presidents:* Prof. Leonard Dickson, Sir Joseph Larmor, Prof. Nörlund, M. de la Vallée-Poussin, M. H. Villat, and M. Volterra. *Secretary:* M. Koenigs.

The delegates numbered 188 and represented 26 nations, amongst which may be mentioned Argentina (4), Australia (1), Brazil (1), Canada (1), Czecho-Slovakia (12), India (2), Japan (2), the Philippine Islands (1), Poland (4), Russia (1), and Serbia (2). The expenses of the congress, including the publishing of the proceedings, have been completely provided for. Of the sum required, 78,000 francs was contributed by public bodies, by industrial and commercial concerns, and by private persons. An interesting fact is that the French Government made its contribution of 10,000 francs through the Ministry of Foreign Affairs, thereby recognising, it would appear, that such a congress has a certain significance in international politics. The subscriptions of delegates produced a further sum of 12,000 francs.

On Thursday, September 23, a general lecture was given by Sir Joseph Larmor on "Questions in Physical Indetermination." Sir Joseph said that of the three physical deductions upon which the validity of Einstein's theory depended, the two which had been verified by experiment, namely, the motion of the perihelion of Mercury and the deflection of light-rays by the sun, could be made to result equally well from a theory involving an æther. But the third Einstein prediction, the displacement of solar spectral lines, was inconsistent with any æther theory. In his opinion, it would be found, when conclusive observations had been made, that the third prediction was not verified. The doctrine that the universe is completely "full" originated with Descartes. The same doctrine was held by Newton, Huygens, Faraday, Fresnel, and Maxwell, but as a much more precise conception. The vortex theory and the elastic solid æther theory had had their day, but there was no reason at present why we should not admit the existence of an æther—a new æther the properties of which were so different from those of ordinary matter that they could be expressed only in terms of non-Euclidean space. The alternative was complete abstraction, the absence of a basis on which to found our theories. The essence of Newtonian space, as enunciated in the works of Lie and Helmholtz, was the possibility of the existence of rigid bodies in motion. Newtonian space was the space of mechanics, for which $dx^2+dy^2+dz^2$ was invariant.

For Faraday and Maxwell, on the other hand, radiation was fundamental. The characteristic of Maxwellian space was *complete transmission*. A pulse travelled without change of form and without leaving anything behind—a principle that was in accord with experiments in light. This was the space of Minkowski, for which the corresponding invariant expression was $dx^2+dy^2+dz^2-c^2dt^2$.

As with Sir Joseph Larmor, so with most of the other contributors to the subject of relativity, the endeavour was directed towards the elimination of those paradoxes which the human mind finds it difficult to accept rather than towards the further development of the theory itself. Thus M. Guillaume, setting forth from the remark that in the theory of relativity we were dealing with the apparent positions of bodies and that the difficulties of the theory arose from the fact that their "real" positions were supposed unknown, offered an alternative analysis in which the initial "real" positions of bodies were supposed known. He obtained results in which some of the paradoxes disappeared. M. Guillaume stated, however, that he had been in correspondence with Prof. Einstein, and had not been able to bring about a reconciliation of the two points of view.

The second general lecture, on "Relations between the Theory of Numbers and other Branches of Mathematics," was delivered on Friday, September 24, by Prof. Leonard Dickson, of Chicago. Prof. Dickson showed how the problem of obtaining rational solutions of certain classes of homogeneous equations was connected with the known properties of certain surfaces and with the theory of hypercomplex numbers.

In a lecture on the teaching of mathematical physics M. Volterra said that what might be called "analytical physics" now constituted an integral whole. Newton had reduced the problem of the universe to a problem in ballistics, and upon this basis Lagrange had founded his analytical mechanics. In a similar way the constitution of matter was for the modern physicist a problem in electricity, and we awaited a new Lagrange. At the present time there were two distinct methods of teaching mathematical physics in universities. The first might be called the *monographical* method. The student followed in succession separate courses in hydrodynamics, optics, and so on. The weakness of this method was that there was no grasp of the subject as a whole. In the other method the student started with a course of mathematical analysis, and, so equipped, he proceeded to the various branches. The fault here was that in the first part of the course he was working without seeing his objective; he did not understand the purpose of his work or see its special difficulties. The course that M. Volterra advocated consisted of three parts. The first, on more or less historical lines, carried the student as far as the general equations. The second part was a discussion of those equations, including a classification of them according to their characteristics and a classification of the problems according to the methods of solution. The third part was the solution and discussion of specific problems. This scheme left for separate treatment those portions of analytical physics which depended upon the calculus of probability, as well as thermodynamics and some minor branches.

M. de la Vallée-Poussin in his lecture, "Sur les fonctions à variation bornée et les questions qui s'y rattachent," dealt with the fundamental theory of integration in the light of Baire's classification of functions. All classes of functions (Baire) are integrable in the sense of Lebesgue. Stieltjes's integral

$$\int_a^b f(x)d\alpha(x)$$

can be defined by the process of Lebesgue, and it exists for all Baire functions f. The functional $U(f)$ (Fréchet and Volterra), which has an assigned value for each of the elements f of a set, can be transformed into a Stieltjes integral. By making use of the univocal correspondence, established by Peano, between the points interior to a rectangle and the points on a segment of a line, functionals depending upon two arbitrary functions can also be reduced to simple Stieltjes integrals.

The subject of the fifth lecture, which was given by Prof. Nörlund, of Copenhagen, was "Les équations aux différences finies." The lecturer gave a very complete discussion of the solutions of equations of the types

$$\tfrac{1}{2}\{\phi(x+\omega)+\phi(x)\}=f(x), \quad \tfrac{1}{\omega}\{\phi(x+\omega)-\phi(x)\}=g(x).$$

In an interesting communication Prof. W. H. Young proposed a new definition, which does not involve an approximation by means of tetrahedra, for the area of a curved surface. The proposal is, first, to define the "area of a curve" as the square root of the sum of the squares of three integrals of the form

$$\int ydz - zdy.$$

Then, the surface being determined by the equations

$$x=f_1(u, v), \qquad y=f_2(u, v), \qquad z=f_3(u, v),$$

suppose the domain of u, v to be divided up into elementary rectangles in the u, v plane. The area of the surface is the limit of the sum of the areas of the corresponding elementary curves.

Prof. Weiss, the director of the Strasbourg Institute of Physics, gave an account of the methods of sound-ranging in use in the French Army during the war. The method normally employed was the same as that in use in the British Army. A useful alternative was the method *à courtes bases*, in which six or more microphones were placed in pairs. The microphones of each pair were about a hundred metres apart, so that the gun locus became a straight line (asymptote), and at once gave the direction of the hostile gun. The installation was very simple, and could be made in an hour, while single sets of observations could be reduced and reported in a minute. This method was used, not for the accurate location of gun emplacements, but for determining quickly which one of the known hostile batteries was in action. Guns were also successfully located by observations of the *onde de choque*. The normals to this wave-surface determine a caustic which is nearly constant in form for high-velocity shells. To locate the gun emplacement, a standard caustic drawn on tracing-paper was fitted by trial to the normals determined by the instruments. This method was used when atmospheric conditions made the spherical wave imperceptible, and, although less accurate, it gave very good results. A case was quoted where 80 per cent. of the hostile emplacements were correctly located solely by *ondes de choque*.

In the course of the congress receptions were held by the Committee of Organisation, the Société des Amis de l'Université de Strasbourg, the Mayor of Strasbourg, and the Commissaire Général (M. Alapetite).

At a concert organised by the Société des Sciences du Bas-Rhin, the delegates had the pleasure of hearing *'s Elsasslied* sung by the mixed choir of the Concordia-Argentina Choral Society. The delegates were entertained at the conclusion of the proceedings at a banquet given by the Organising Committee.

The invitation conveyed by Prof. Leonard Dickson to hold the next congress in New York in 1924 was accepted, and a further invitation was received to hold the congress of 1928 in Belgium. H. B. H.

Disorders of Symbolic Thinking.

DISCUSSION AT THE CONGRESS OF PHILOSOPHY AT OXFORD.

SEVERAL subjects of direct scientific interest were discussed at the Congress of Philosophy held at Oxford on September 24–27. One of the greatest importance, because based on recent clinical and experimental research, was the discussion introduced by Dr. Henry Head in a paper entitled "Disorders of Symbolic Thinking due to Local Lesions of the Brain." It raised the whole problem of the relation of language to thought while concentrating attention on the significance of certain definite observations—cases of young men who had received cerebral injuries in the war—in which the injury to the brain had affected the power of articulation.

Dr. R. Mourgue, of l'Asile de Villejuif, also contributed a paper, and was announced to take part in the discussion. He was unable to be present, however, and his place was taken by Prof. Bergson.

Dr. Head said that his general conclusion from the cases he had studied experimentally, where gross destruction of brain-tissue had resulted in loss of speech, was that there always remained elements in thought which were not associated with words. Speech is a discriminative movement capable of fine degrees of adjustment, essentially an intellectual mechanism. Even in the gravest cases of aphasia the patient is evidently fully aware of his emotions, and can express them clearly in gesture and action. Under the influence of emotion he may even use words or phrases which he is quite impotent to evoke voluntarily. Speech can be disturbed, or even totally lost, without reducing the patient's intellectual capacity or of necessity producing grave intellectual defect. All the early work of investigation of aphasia had been vitiated by the conception that speech was a well-defined intellectual function, strictly localised in some particular site in the brain. Attention was concentrated, therefore, on correlating the extent of anatomical destruction on this site with the character of the disorder of speech. The fundamental error at the root of all this work is its ignoring of the physiological changes which intervene between the anatomical lesion and the psychical states with which it is associated. Destruction of the substance of the brain disturbs the act of speech only because it interferes with the physiological processes necessary for its perfect execution.

Dr. Head then described the nature of his experiments and the means he had devised to discover the physiological processes with which the particular injuries had interfered. In the older theories auditory images were supposed to be responsible for "memories" of words, and these were said to be stored up in certain areas of the cortex. The hypothesis is entirely unable to explain the phenomena of aphasia. Patients who cannot name consecutively a series of objects in front of them can choose them correctly when the name is given either orally or in print. It is the name, not the auditory image, which is lacking. The loss of the power to use words is not due to a destruction of images.

What, then, Dr. Head asked, are the functions which are disturbed in aphasia? The true answer had been given so long ago as 1868 by Hughlings Jackson, though its significance was not then seen. The chief mental activity disturbed by unilateral lesions of the brain was declared to be the use of words in propositions. The loss of function in aphasia might therefore be indicated as that of "propositionising." But though this term suggests a conception which covers the larger number of facts, it does not comprise every aspect of the loss of function. Dr. Head suggested, therefore, that these functions should be spoken of as "symbolic thinking and expression," though even this phrase does not quite satisfactorily define the group of processes affected. It is not all symbolic representations, but symbols used in a particular manner which suffer in these disorders. There are four fairly well marked groups of functions into which he now proposed to divide "symbolic thinking and expression" on the ground that they are dissociated in different ways under the influence of organic injury. These are (1) verbal defects, (2) syntactical defects, (3) nominal defects, and (4) semantic defects.

Dr. Mourgue's contribution was in no sense opposed to Dr. Head's conclusions. It dealt with a rather different aspect of the case, and seemed indeed to supplement the general theory in a remarkable way. Dr. Mourgue had given particular attention to some characteristic cases of aphasia in which the sufferers were themselves skilled in the treatment of the disorder and able on recovery to record and analyse their experience. The particular cases cited were the autodiagnosis of Dr. Saloz and Prof. Forel, and also a case recorded by van Woerkem. In all these cases the speechlessness of the aphasic state was comparable with the kind of indistinctness of psychical elements often experienced in the dream state. There was complete preservation of intuitive thought, but absence of imagery, or at least of verbal imagery. The will is unaffected, and may even show exaltation, but there is an absence of discrimination and differentiation—characters which, from a somewhat different point of view, Prof. Bergson has described as essentially belonging to intelligence.

Prof. Bergson said that the communication which Dr. Head had presented constituted a complete rejection of the theory of aphasia which for a long time had been classic. It offered in its place the quite new theory that aphasia was the disorder of a special faculty of symbolising, which might be said to be a certain aspect of intelligence. The classical theory of aphasia might be described as a complete metaphysic. So long ago as the years 1892 and 1893 he had himself been led by a question of pure metaphysics to study the relation of mind and body. He found that philosophers had given us only very vague ideas on this subject, and he determined, therefore, to study the facts of the relation without any philosophical presuppositions. It was extraordinarily ambitious, for he had no technical-scientific equipment. Gradually, however, the problem of the relation of mind and body transformed and narrowed itself into the problem of the relation of memory to the brain, then of the memory of words, and then of the meaning of words. Surprise followed surprise. The theory of Broca then held the field, complicated by the work of Kussmann and Lichtheim. Nerves converge on nervous centres, there are strange communications between the centres, the path from A to B is not the same as the path from B to A, and every theory called for some new theories to explain each particular case studied. He appealed to his neurologist and psychologist friends, but he was ill-received; and when some years later he attacked their theories in his book he was looked on with pity. He was not surprised, therefore, when Prof. Pierre Marie gave the results of his anatomical researches, based on Broca's work, and, indeed, on a restudy of the actual brain which Broca had dissected. Long before this, psychology had itself shown the old theory to be impossible. The theory had, in fact, broken down before a psychology of common sense which called for scarcely any effort of introspection. A perception, in fact, is already memory, for a perception has duration. A part of the perception is memory, therefore, even while the perception still remains. Where does perception begin to be past? All the hypotheses were contradicted by simple self-observation. Prof. Pierre Marie proceeded to demonstrate a new theory of aphasia. He reduced it to two things: (1) A certain disorder of articulation which he named *anarthrie*, and (2) a certain enfeeblement of intelligence.

Prof. Bergson then referred to his own studies of aphasia. What had struck him most forcibly in the records of a great number of cases was a certain powerlessness in the patient to analyse or decompose his perception. Deafness to words was a concomitant symptom rather than a distinct factor. There were cases where persons after complete recovery and restoration had described their experience by saying that they heard perfectly well, but seemed to be listening to a continuous sonorous blur. One of Charcot's patients could hear the clock strike quite well, but could not distinguish the strokes. In verbal blindness, another form of aphasia, it is very remarkable to observe in some of the cases the difficulty the person has to decompose and analyse his perception. He will want, for example, to write a letter of the alphabet, and may succeed, but he will begin where he would not ordinarily begin; he is seen to lack the sense of the organisation of the letter, and when he produces it he has not synthetically constructed it. When we listen to persons speaking a foreign language we are in the condition of some of these aphasics. We hear perfectly, but we cannot repeat the whole of the sounds; they appear to us crushed, as it were, into a formless mass without bones or joints, a sonorous continuity. He had himself, following another line of investigation, been led to attribute capital importance to nascent movements, tendencies, and outlined actions—movements sketched, as it were, and not carried out. An idea is a grouping together of virtual actions. The continuity of thought is simply a continuity of attitudes and of virtual movements not executed, sometimes scarcely delineated. The brain, and in particular the cerebral cortex, indicates an enormous number of initiated actions. Instead of considering the spinal cord as a diminished brain, we ought to think of the brain as a completed spinal cord. Coming back to the special case of aphasia, he asked himself whether, in order to understand speech, we had not got to undertake a work of disintegration of the movements of articulation, neither completely voluntary nor completely automatic. There are certain beginnings of movements which are not carried out. They are partly automatic, partly voluntary, for our mind projects our actions in advance of their accomplishment.

Prof. Bergson concluded by expressing his profound admiration of Dr. Head's researches on the question of aphasia; they appeared to him of capital importance for psychology, and even for metaphysics.

University and Educational Intelligence.

BIRMINGHAM.—An appeal is being issued for 500,000*l*. in aid of the funds of the University. The finances are in a critical condition; there is a debt of 130,000*l*., which absorbs at present 8000*l*. per annum, necessary extensions of building have had to be made, the staff is deplorably underpaid, and the entry of new students is a heavy one. In spite of the 25 per cent. increase in the fees of new students, these fees will still represent only about 30 per cent. of the cost of providing the instruction, so that the greater the entry the greater the need for money.

This session the working of the faculty of science will be rearranged, much of the work previously done by the meetings of faculty being delegated to Boards of Studies. The latter consist of professors and selected members of the non-professorial staff, and the following boards have been constituted: Mathematics, physics, chemistry, engineering, and biology. It is hoped that the new arrangement will do something towards relieving the congestion of business in the faculty, which has recently been serious. The boards will report to the faculty.

CAMBRIDGE.—Dr. Ff. Roberts, Clare College, has been appointed junior demonstrator in physiology, and Mr. T. R. Parsons, Sidney Sussex College, additional demonstrator in physiology.

The Vice-Chancellor has announced a very generous gift of 25,000*l.* from Sir Dorabji Tata, Gonville and Caius College, towards the expense of new buildings for the engineering school. A further anonymous gift of 2000*l.* has also been received. Part of the new buildings are already very nearly complete. Amongst the large entry this year are to be found fifty officers of the Royal Engineers and a small number of officers from the Royal Air Force and the Corps of Signals—a welcome connection between the Services and the scientific side of the University. The number of naval officers in residence has been reduced owing to the heavy pressure on the accommodation. The question of the admission of women to the University comes up for discussion in the Senate House on Thursday, October 14.

DR. JAMES G. GRAY, lecturer in physics at the University of Glasgow, has been appointed to the newly established Cargill chair of applied physics in the University.

THE *Times* announces that Mr. T. D. Owen, a leading Welsh metallurgist, has given 10,000*l.* to the University College of North Wales for the foundation of a chair in his name of electrical engineering and hydro-electrics.

DR. J. NEWTON FRIEND, hitherto headmaster of the Science and Technical School, Victoria Institute, Worcester, has succeeded Dr. T. Slater Price as head of the chemistry department of the Birmingham Municipal Technical School.

DR. MARION B. RICHARDS, of the chemistry department of Aberdeen University, has been appointed assistant to Dr. R. H. A. Plimmer, head of the biochemical department of the Rowatt Research Institute in Animal Nutrition, Aberdeen.

IT is announced by the *Times* that Prof. A. B. Macallum, professor of biochemistry in the University of Toronto, and administrative chairman, honorary Advisory Council for Scientific and Industrial Research of Canada, has accepted the new chair of biochemistry at McGill University.

DR. C. DA FANO will begin a special course of eight lectures on "The Histology of the Nervous System" in the physiology lecture theatre of King's College, University of London, on Wednesday, October 13, at 4.30 p.m. The course is free to all students of London colleges and to medical men and others on presentation of their visiting-cards.

AT a meeting of the Old Students' Association of the Royal College of Science to be held on Tuesday next, October 12, at the Imperial College Union, Prince Consort Road, South Kensington, London, S.W.7, Mr. J. W. Williamson will deliver an address entitled "The Proposed University of Science and Technology: Can a Useful and Worthy University be Based on Pure and Applied Science?" The chair will be taken at 8 p.m. by the president of the association, Sir Richard Gregory.

IN connection with the University Extension Board of the University of London, Prof. John Cox will commence on October 8, at 7.30 p.m., an interesting course of lectures on "The Bases and Frontiers of Physical Science" at Gresham College, Basinghall Street, E.C.2. The first part of the courses will be devoted to a review on the broadest possible lines of the concepts and laws of Nature on which traditional physics has been built up. The later lectures will deal with Einstein's views and the principle of relativity. Admission to the first lecture is free.

Societies and Academies.

PARIS.

Academy of Sciences, September 13.—M. Léon Guignard in the chair.—F. E. **Fournier**: The apparent displacement of some stars in the total eclipse of the sun of May 29, 1919.—A. **Blondel**: The calculation of electric cables by the use of vectorial functions with real notation. The method described has the same advantages as when imaginary quantities are employed, but only real quantities are utilised in the demonstration. It is based on the introduction of vectorial series.—V. **Smirnoff**: Some points of the theory of linear differential equations of the second order and automorphic functions.—E. **Jouguet**: The velocity of waves in elastic solids.—C. **Camichel**: The transmission of energy by the vibrations of water in pipes. Remarks on some recent publications of M. Constantinescu, and a statement of the work done by the author on the same subject.—E. **Canals**: The estimation of calcium and magnesium in different saline media. A study of the conditions under which, in acetic acid solutions, it is possible to separate completely calcium and magnesium from salts of iron and aluminium.—G. **Zeil**: The *rôle* of building corals in lithospheric re-adjustments.—C. **Störmer**: Some rays of aurora observed on March 22, 1920, which reached a height of 500 km. The aurora borealis of March 22 was photographed from seven stations under favourable conditions. The stations were connected by telephone, and simultaneous photographs were taken from two or three stations at a time. About 620 photographs were obtained, and they show that the summits of some of the rays reached an altitude of 500 km. above the earth.—A. **Chevalier**: The origin of the cider apple-trees cultivated in Normandy and Brittany.—F. **Vlès**: The spectral properties of the tetanus toxin. Spectrophotometric studies of the ultraviolet absorption spectra of the effects of heating and of the addition of antitoxin to solutions of the tetanus toxin.—A. **Marie** and L. **MacAuliffe**: The influence of life in Paris on the race. A study of 1509 Parisians of the poorer classes, 850 of whom were born of provincial parents, 294 of Parisian parents, and the remainder of one Parisian and one provincial parent. The Paris climate and town life lead to modifications which are thus summarised: The hair and eyes less pigmented than in the rest of France, more marked cranial development in proportion to height, and shortening of the limbs.—J. L. **Dantan**: Budding in *Antipathella subpinnata* and *Parantipathes larix*.

HOBART.

Royal Society of Tasmania, August.—His Excellency Sir W. L. Allardyce, president, in the chair.—H. H. **Scott** and C **Lord**: *Nototherium Mitchelli.* Its evolutionary trend: the skull and such structures as related to the nasal horn. In their third paper on the

Smithton discovery the authors deal with a mass of data relating to the evolutionary trend of the Nototheria and the structure of the skull. They also deal with a reclassification of the genus. The Nototheria are a group of animals that in Tasmania became extinct late in Pleistocene times. They were generalised, and yet in part specialised. They retained the racial characteristics that can be relegated to five geological periods—that is, from the pre-Eocene to the latest Pleistocene. They show similar developments to those of the perissodactyl ungulates, and, without leaving a single modern representative to carry on their race in totality, they left many characters scattered through their marsupial allies, the kangaroos, wombats, and native bears, which still grace our woodlands to-day. In dealing with the taxonomic data relating to the skull the authors recognise two well-marked groups, namely: Group i., Megacerathine, and group ii., Leptocerathine.—H. T. Parker: Mental efficiency. A study of the results obtained by testing children by the Binet-Simon scale.

Books Received.

The Cactaceæ: Descriptions and Illustrations of Plants of the Cactus Family. By N. L. Britton and J. N. Rose. Vol. ii. Pp. vii+239+xl plates. (Publication No. 248.) (Washington: Carnegie Institution.)

Geometrical Investigation of the Formation of Images in Optical Instruments. Embodying the Results of Scientific Researches Conducted in German Optical Workshops. Edited by M. von Rohr. (Forming vol. i. of "The Theory of Optical Instruments.") Translated by R. Kanthack. Pp. xxiii+612. (London: H.M. Stationery Office.) 2*l.* 5*s.* net.

Technical Handbook of Oils, Fats, and Waxes. By P. J. Fryer and F. E. Weston. Vol. i.: Chemical and General. Third edition. Pp. xii+280+xxxvi plates. (Cambridge: At the University Press.) 15*s.* net.

Commonwealth of Australia. Papua. Annual Report for the Year 1918–19. Pp. 119. (London: Australia House, Strand.)

The Human Atmosphere (The Aura). By W. J. Kilner. Pp. vii+300. (London: Kegan Paul and Co., Ltd.) 10*s.* 6*d.* net.

Mathematical Papers for Admission into the Royal Military Academy and the Royal Military College and Papers in Elementary Engineering for Naval Cadetships and Royal Air Force. November, 1919, and July, 1920. Edited by R. M. Milne. Pp. 34. (London: Macmillan and Co., Ltd.) 1*s.* 9*d.* net.

Diary of Societies.

THURSDAY, OCTOBER 7

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Major-General Sir F. H. Sykes: Civil Aviation.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. C. W. Kimmins: The Handwriting of the Future.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—The President: Spoon-shaped Depressed Birth Fracture of the Frontal Bone treated by Elevation.—Dr. M. Kerr: (1) The Surgery of the Uterus Bicornis Unicollis, with a case of Resection of the Uterus followed by two Normal Pregnancies; (2) The Intra-vesical Repair of Inaccessible Vesico-vaginal Fistula.—Dr. A. J. McNair: A Case of Placenta Prævia with Vasa Prævia.—H. Briggs: (Presidential Address), The Female Pelvic Floor. (Neurology Section), at 8.45.—Dr. H. Head: (Hughlings Jackson Lecture), A New Conception of Aphasia.

FRIDAY, OCTOBER 8.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.—Z. Cope: The Clinical Significance of Shoulder-pain in Upper Abdominal Lesions.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—R. A. Malby: A Miniature Alpine Garden.

MONDAY, OCTOBER 11.

BIOCHEMICAL SOCIETY (at King's College), at 5.

ROYAL SOCIETY OF MEDICINE (War Section), at 5.30.—Wing-Commander Martin Flack: Medical Requirements for Air Navigation.

MEDICAL SOCIETY OF LONDON (at 11 Chandos Street, W.1), at 8.—Annual General Meeting. At 8.30.—Sir William Hale-White: (Presidential Address), Then and Now.

TUESDAY, OCTOBER 12.

SOCIETY FOR THE STUDY OF INEBRIETY (at Medical Society of London), at 4.—Dr. J. A. Davidson, and others: Discussion on Special Clinics for Inebriates.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—(Annual Traill Taylor Memorial lecture), Prof. A. E. Conrady: The Present State of Photographic Optics.

WEDNESDAY, OCTOBER 13.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 8.—Sir Henry Fowler: Presidential Address.

HUNTERIAN SOCIETY (at Sion College), at 9.—Sir George Newman: The Ministry of Health as an Instrument in Preventive Medicine.

THURSDAY, OCTOBER 14.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—H. A. Hughes and P. F. Everitt: The Field of View of a Galilean Telescope.—B. K. Johnson: The Calibration of the Divided Circle of a Large Spectrometer.

INSTITUTION OF AUTOMOBILE ENGINEERS (at 28 Victoria Street), at 8.—Graduates Meeting. Messrs. Chatterton and Watson: Factors affecting Power Output.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Dr. E. S. Reynolds: (Presidential Address), The Causes of Nervous Disease.

FRIDAY, OCTOBER 15.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—T. M. Ainscough: British Trade with India.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Keith: Demonstration on the Contents of the Museum.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—A. Keighley: An Evening in Lakeland.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—S. Gilbert Scott: Presidential Address.

SOCIETY OF TROPICAL MEDICINE AND HYGIENE, at 8.30.

SATURDAY, OCTOBER 16.

PHYSIOLOGICAL SOCIETY (at Guy's Hospital), at 4.

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Editorial and Publishing Offices:
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The Site of the University of London.

THE Senate of the University of London will at its next meeting be called upon to make a definite decision regarding the Government's offer of the Bloomsbury site. Mr. Fisher has intimated, and in our opinion not unreasonably, that the offer cannot remain open longer.

The matter has been very fully canvassed during the recess, and the Senate has had leisure and opportunity to consider the issues involved by acceptance or rejection of the Government's offer. For reasons which we have already given, we most earnestly hope that the Senate will decide to adopt the report of its sites committee, which, it is understood, has with certain reservations recommended acceptance of the offer. The discussions of the last few months, so far as they have been relevant, have served only to strengthen our conviction that a refusal will mean the indefinite postponement of a step which is both urgent and necessary for the proper development of the University.

The fact that so much of the discussion has been irrelevant and misinformed is in itself evidence, if evidence were needed, of the failure of the University to impress itself upon the imagination and intelligence of many who are genuinely concerned for higher education in London. Correspondence in the Press has shown beyond doubt that there does not exist any widespread knowledge either of the magnitude of the present activities of the University, or of the nature of its present urgent needs.

The attention which has been given to the suggestion that "The University" should migrate to Hampstead is an illustration. Ken Wood is a delightful spot, and entirely suitable for a residential college or for hostels. But a dozen Ken Woods could not contain the teaching work of the University, and, what is more, they are not wanted. The University of London, or any University of London, must permeate London. Its thousands of students must be distributed, as they are now, throughout London—in the incorporated colleges, in the various "schools" from Kensington to the Mile End Road, in all the great hospitals, and in institutions easily accessible to evening workers. This or some similar arrangement is a necessity for a University of London, and no one building, whether at Hampstead or Bloomsbury or elsewhere, could or should contain the teaching work of the University.

The urgent needs of the University are, we take it, two. They are the provision of suitable administrative headquarters and of a new home for King's College. The need for providing a unifying and co-ordinating centre for the manifold activities of the University is patent. The lack of an adequate home peculiarly and distinctively associated with it has been an obstacle to its progress since its reconstitution. The buildings at South Kensington, dignified though they be, were not designed for their present purpose; they are not suitable for it, nor are they easily accessible. Further, so long as they continue to be known as "The Imperial Institute" rather than "The University," confusion must inevitably persist.

The case is clear for a new building which shall provide accommodation for the administration, for the libraries, for examinations, and for a meeting place where the multitudes of the teachers and students of the University can come together for business and recreation.

The need for a new home for King's College is no less pressing. It has long out-grown the buildings in which it has lived for nearly a century, and its removal to some other site is imperative.

Bloomsbury is indisputably the most convenient quarter both for an administrative centre and for the new home of King's College, and it is the absence of any real alternative to it that is the strongest argument in its favour. The accessibility, the proximity of University College, and of other university organisations, allow and encourage co-operation and obviate the waste of time and the profitless wear-and-tear which are inseparable from the present arrangement.

There remains the question of finance, which we have from the beginning recognised as the really serious question. This has been complicated, unnecessarily we believe, by a comparison of the supposed value of the present King's College site with the Bloomsbury site; but if the former is, as appears to be admitted, inadequate for its purpose, a comparison of site values seems beside the point, and it is surely no derogation to a good bargain that both parties derive benefit from it. The criticism that the Government should continue to be responsible for rates and maintenance charges is of a different kind. Here we think the Senate was on strong ground, and we are glad that it has elicited from Mr. Fisher a statement that these charges will continue to be borne by the Government.

We are glad, too, to see the explicit declaration of the President of the Board of Education that acceptance of the Bloomsbury site will not close the door against building grants from the Treasury. Apart from the technical obstacle to a Government pledging its successors to expenditure for this purpose, it is, we think, apparent that at the present time the Government, faced with demands for economy, might well hesitate to promise unconditionally a large sum for buildings. On the other hand, we are convinced that if the University embarks in earnest upon the provision of a building, neither this nor any future Government could or would withhold its support.

We can only repeat our most earnest hope that the University will decide to accept the Government's offer. The present time may not be the most propitious for embarking upon an appeal for funds, but we are convinced that a courageous policy is the right one, and that the Senate, if it fails to take advantage of the opportunity now offered to it, will have done a serious injury to the future of the University, and lost for many years any claim upon the Government or the public.

Women at Cambridge.

AT Cambridge to-day, October 14, is to be held the official discussion of the proposal to admit women to the membership of the only University in the Empire which gives women no rights. Weeks of somewhat bitter fighting in the Press will follow, and the vote should be taken towards the end of this term or early next term. We will for the moment consider only how the interests of scientific teaching and research are affected by the proposals.

Two reports are to be presented for discussion. Report A proposes a simple statute for adoption, the net result of which is to give women the same opportunities and rights within their own colleges as men have in theirs. They will, as at present, attend the regular courses of teaching in the University and take the University examinations. There will, however, be this difference: success in the examinations will secure for them a degree, as in the case of men students, and women will be able to compete for University prizes, scholarships, and studentships from which they are now debarred. The degree will secure for them in due course, as for men, voting power in the University; at present they receive only the Parliamentary vote for the University member, and a place in a published class list in return for success in the University final examinations. Thus it is proposed that an anomalous and unsatisfactory state of affairs should be ended, and equality of opportunity secured for men and women inside the University. Provision is rightly made in the proposed statute to secure the rights of past students of Girton and Newnham to degrees.

As regards the colleges, the supporters of Report A recognise fully the need to guard against men and women both being members of the same residential college. They therefore propose that the University shall refuse to recognise in any way a woman as a member of a men's college or a man as a member of a women's college. The University has no power to stop a men's college from admitting a woman, but it can see to it that a woman shall gain nothing, so far as the University is concerned, by joining a men's college, and that is what Report A provides for. It should be added that, in this matter, full support is given by the authorities of Girton and Newnham Colleges. The bogey of the mixed college is conjured up only by the supporters of Report B in the hope of securing votes for their scheme. At any rate, they suggest no steps to guard against it.

By the alternative scheme proposed in Report B, the University is to give its blessing to the foundation of a women's University at Cambridge, and to express a desire to continue to afford to students of the new University the privileges as regards instruction, examination, and access to libraries, museums, and laboratories which are at present accorded to students of Girton and Newnham Colleges. This gives the women their degrees, not of Cambridge University, but of a new University at Cambridge. There are arguments on both sides on this point based on sentiment. One real grievance, at any rate, is partly met. No guarantee is, however, offered that existing facilities generally given to women will be continued. They are now admitted to laboratories and lectures only by the courtesy of professors and other teachers. Cambridge is at present suffering from severe pressure on its accommodation. Under Report B women might well be crowded out from laboratories to make room for members of the University—this is fully recognised by the supporters of Report B; that is to say, the report amounts to a desire to assist in the teaching of women so long as the number of men students leaves room for them and no longer. It is no wonder that the councils of the women's colleges at Cambridge have emphatically repudiated such a scheme, and have declared that if Report B is adopted at Cambridge they would take no steps to promote the incorporation of Girton and Newnham Colleges as a separate University. It is no longer possible, in our view, for a university, in sorting out its excess applicants for entry, to take sex as the first and supreme test: intellect and the needs of the nation are both safer tests in the interest of the university and of learning.

One more point in which Report B singularly fails to make good the claims of its supporters may be briefly mentioned. As regards the admission of women to the men's colleges, and through the colleges to the University, it leaves the door wide open as it has stood since the Sex Disability (Removal) Act. It is Report A, and not Report B, which takes safeguards against what is admitted on all sides to be undesirable. It is Report A which, with this precaution, gives women the fullest equality of opportunity with men inside the University.

Lunar Tables.

Tables of the Motion of the Moon. By Prof. Ernest W. Brown, with the assistance of Henry B. Hedrick. Sections i. and ii., pp. xiii + 140 + 39; section iii., pp. 223; sections iv., v., vi., pp. 99 + 56 + 102. (New Haven: Yale University Press; London: Humphrey Milford; Oxford University Press, 1919.) Price, 3 vols., 4 guineas net.

THE appearance of Prof. E. W. Brown's lunar tables marks the accomplishment of an arduous task of the highest importance to astronomy. In the two centuries which have elapsed since the time of Newton more than a score of tables have been published. The majority of them naturally belong to the eighteenth century, and no longer possess any practical interest apart from the theories on which they were based. If they did not always mark any very distinct advance in accuracy beyond their predecessors, they generally aimed at including a greater number of inequalities more precisely determined, and systematic observation of the moon was all the time accumulating the material which could be used for comparison with theory and the better determination of the fundamental constants. Newton himself discussed eight lunar inequalities. Euler in his memoir of 1772 included twenty-one inequalities each in the longitude and the radius vector and sixteen in the latitude. This was only a beginning. As time went on and the standard of achievement grew more exacting it is not surprising to find that the number of men who possessed both the ability and the patient energy to elaborate complete and independent theories of the moon's motion and to reduce them to the form of practical tables became notably smaller. Thus when Burckhardt's tables of 1812 had once been adopted in such annual publications as the Nautical Almanac, overcoming the rival claims first of Bürg and later of Damoiseau, they continued in use for the best part of half a century, although their deficiencies ultimately amounted almost to a scandal, and their form rendered it particularly difficult to reconstruct the underlying theory and to apply the needful corrections. A serious error in the parallax according to these tables was found and corrected by Adams.

The Greenwich lunar reductions undertaken by Airy, by which the results of eighty years' observations were made available, proved the need for greatly improved tables, and provided the most valuable material on this side for making an advance. By that time it was known that Hansen was engaged in lunar researches having for their ultimate object the preparation of entirely new tables, and their appearance was eagerly awaited. But for a time difficulties threatened to intervene. Born in Schleswig in 1795, Hansen is an outstanding example of that singularly rare class, the self-taught mathematician. Owing nothing to academic education, he succeeded Encke in 1825 in the direction of the observatory at Gotha, and thereafter until the end of his long life refused all offers of preferment, though observatory and stipend were alike of the most modest. In these circumstances he received help from the Danish Government, but when this was discontinued in 1848 owing to financial stringency and the steady progress of the work was in danger, the British Admiralty came to the rescue on the representation of Airy in 1850, and not only provided the comparatively small sum needed to complete the work, but also undertook the expense of printing the tables, which accordingly were ready for distribution in 1857. As his earliest researches on the subject were published in 1829, it may be taken that the work filled the main part of Hansen's life for a period of about thirty years.

No excuse is needed for recalling these circumstances at the moment, sixty years later, when Hansen's tables are on the point of being finally superseded. They are not faultless, it is true, and for many years past certain corrections introduced by Newcomb have been adopted in the national ephemerides. But, on the whole, they have served the practical needs of two generations admirably. In Hansen's theory, on which the tables are based, the number of periodic terms had grown to about three hundred. Those which depend on the solar action were for the most part well determined, but those which arise from planetary action were neither complete nor accurate. It is but fair to remember, however, that in previous tables the latter class of terms had been ignored altogether. Considered purely as tables in the technical sense, Hansen's possess acknowledged merits. As a practical computer himself, he had the advantage of great experience and exceptional natural gifts. It is said that in a matter of four-figure logarithms he rarely had need to refer to the tables.

But during the later stages of his researches Hansen was not the only worker on the large scale in the field of lunar theory. Some ten years earlier Delaunay had begun the construction of a theory in purely algebraic form by an original method of integration, and by 1867 that part which depends on the direct action of the sun had been completed and published. His intention had been to add those complementary parts which still remained necessary and to proceed to the reduction of the whole to a numerical and tabular form. This was not to be. Historical events supervened and delayed the progress of the work. Then in 1872 he lost his life by drowning, and his life's work, which had always been pursued without assistance, came to an untimely end. Yet his projects were destined to be accomplished by other hands. The planetary inequalities were calculated by Radau in an admirable memoir, and under his direction the reduction of Delaunay's theory to tabular form was completed before the death of Radau in 1911. From 1915 the lunar ephemeris in the "Connaissance des Temps" is based on these tables. Prof. Brown remarks justly that the value of the purely algebraic development is not seen at its best in the numerical form, owing to the slow convergence of certain classes of coefficients. He also criticises the form of the tables, but this is a matter which will chiefly concern the French computer, and need not affect our appreciation of an independent lunar ephemeris. The value of Delaunay's method is not confined to his own application of it to the lunar theory. But even this can be no ordinary work, which, executed within a few years of Hansen's, assumes a new vitality after lying dormant for half a century.

The new tables of Prof. Brown will be used for the first time in the Almanacs of 1923, and a confident hope may be expressed that they will continue in use for a very long time to come. They are the final outcome of thirty years' work, and, long as this time is, Prof. Brown is to be congratulated equally on the rapidity and on the thoroughness of his labours. For the number of terms now included falls little short of 1500, and, so far as can be now seen, the expression of the effects of purely gravitational action cannot profitably be pushed further. All this work, which is completely new from the beginning, was not contemplated as an integral plan from the start, but grew by successive stages, as Prof. Brown tells us, out of a suggestion by Sir G. H. Darwin to make a study of Hill's papers. The preparation of the theory, which was published in the Memoirs of the Royal Astronomical Society, was finished in 1908, and the liberality of Yale University in undertaking the whole cost of the tables made it possible to proceed with plans for the final stage without delay and without anxiety. Thus the author has been spared some of the cares which fell to the lot of Hansen. None the less, the British Admiralty has once again played a small part in the matter, though in a different way. With proofs and MS. continually crossing the Atlantic during the war, it is recorded that only one set of returning proofs was lost.

It is unnecessary to recall the details of the author's theory. Hill, to whom its foundations are very largely due, was, like Hansen, a practised computer. Though his researches in this field have incidentally enriched celestial mechanics, and even mathematics in general, with new and fertile conceptions, his motive was essentially a practical one. It was to find a path which would lead to the highest possible accuracy in the final results with the greatest economy of labour. The soundness of his ideas can be properly tested and appreciated at no stage short of the fulfilment which Prof. Brown has given to them in this great work. There can be no doubt not only that Prof. Brown has accomplished a worthy and most valuable task, but that he has also with equal judgment employed in the course of it the best available methods.

Sections ii.–vi. contain tabular matter exclusively. The explanation of the tables is contained in the ten chapters of section i. This appears to be a model of clearness. Except in chronological questions and in special researches the ordinary astronomer rarely has occasion for single places of the moon outside the range of the hourly ephemeris provided in the Almanacs. The chief function of the tables therefore lies in the calculation of this ephemeris from year to year, and this fact has been kept in view in their arrangement. Advantage has been taken of Hansen's example to the extent deemed profitable, and a number of original devices have been introduced, including a new scheme of re-entrant arguments. By these means it is believed that the computation of an ephemeris will be at least as rapid as with Hansen's tables, in spite of the inclusion of about five times as many terms. An accumulation of errors in the sums of many tabular entries is unavoidable. From this source probable errors of $0{\cdot}04''$ in the longitude or latitude, and of $0{\cdot}003''$ in the parallax, are expected after these co-ordinates have been finally contracted to one decimal place less. Imperfections in the adopted constants and cumulative small defects of theory may raise these amounts to $\pm 0{\cdot}1''$ and $\pm 0{\cdot}05''$ respectively. Clear instructions are given for making such adjustments in the fundamental constants as may hereafter prove necessary. But there need be no illusion that the moon will actually follow the strict gravitational path laid down so carefully in these tables. As it is, the empirical term

$$+10{\cdot}71'' \sin\{140{\cdot}0^\circ(t_c-18{\cdot}5)+170{\cdot}7^\circ\},$$

with a period of 257 years, has been admitted in the longitude, with consequential changes in the arguments of some other terms. In magnitude this is comparable with the great Venus term, and the explanation of it is still to seek. Discrepancies will recur, and the advantage to be expected from the new tables is that they will no longer be entangled with the errors of a faulty ephemeris. If this hope is realised—and there is no reason to doubt that it will be—unstinted gratitude will be due to Prof. Brown and to those who have assisted him either by active collaboration or by financial aid.

The tables have been printed in England at the Cambridge University Press. The paper is of an unusually sumptuous and durable quality appropriate to a work of lasting value which will have to bear repeated handling for a long time. The type is admirably clear. Only one superficial point suggests adverse comment. The pagination is peculiar. In their present form the tables consist of six sections in three volumes. Each section, of length varying from 39 to 223 pages, is paged independently from 1 onwards. In whatever form the work is finally bound, this will surely prove an inconvenient plan for any purpose, such as the correction of errata. A continuous sequence would have been preferable. But perhaps there will be no errata (beyond one already noted), and in any case the blemish, if it be one, is trivial.

H. C. P.

Genesis, Evolution, and History.

The Evolution of the Earth and Its Inhabitants. By Joseph Barrell and Others. A Series of Lectures delivered before the Yale Chapter of the Sigma Xi during the Academic Year 1916–1917. Pp. xiv+208+iv plates. (New Haven: Yale University Press; London: Humphrey Milford; Oxford University Press, 1918.) Price 10*s*. 6*d*. net.

THIS book consists of five lectures by five experts, who deal with various aspects of evolution. The range extends from the nebula to modern civilisation, and the wonder grows that one word can cover it all. We feel as if the word "evolution" were in danger of becoming like a household knife—used in so many ways that it tends to become useless. The use of the same term for so many different kinds of becoming is apt to suggest that they are all describable by the same formulæ. To avoid this fallacy, might it not be well to find differentiated terms, such as *genesis* in the domain of things, *evolution* in the realm of organisms (keeping *development* for the becoming of the individual), and *history* for the kingdom of man?

The first lecture deals with the genesis of the earth and of the parent solar system, and, the establishment of the earth having been accounted for, its subsequent changes are traced until the time of its becoming a fit home for life. Prof. Barrell adopts the theory of the origin of the earth as a secondary spiral nebula heaved off from the central sun as the result of tidal forces produced by the close approach and passage of another star. He favours the hypothesis of earth-growth by the rapid infall of planetoids (not by Chamberlin's "slow accretion of planetesimals") and the hypothesis of an earth initially molten.

The second lecture, by Prof. Schuchert, discusses the changes of the earth's surface and climate during geologic time, which the author is inclined to put at about 800 million years. The constant shrinkage of the earth leads to an instability of surface that brings about periodic changes, not only in the areal space-relations of water and land, but also in the shapes and heights of the lands. As the lands are elevated, the weathering becomes more active and the high places are brought down to the sea. The waters are thus to a certain extent displaced, and periodically flood more or less of the lands. Every now and then, when the lands are largest, highest, and driest, a cold period sets in and disarranges the whole organic world. During these critical times the earth is scenically grand, and the struggle for existence unusually intense. The over-specialised types give place to smaller, less specialised, more plastic types. The unadaptive types become extinct, or are pressed into corners and refuges. Some adaptive stocks find relatively easy haunts, as in the sea, but from such there evolves no great mentality. The highest organisms, with the greatest mentality, have evolved on the land, "where the struggle for existence is fiercest, because of the constant necessity of adaptation to an environment subject to intense changes. Organic supremacy is attained only through constant vigilance."

In the third lecture Prof. L. L. Woodruff gives a clear and critical account of the various suggestions that have been made in regard to the origin of organisms, cautiously favouring the uniformitarian idea that they arose from not-living matter upon the earth.

Of great interest is the fourth lecture, in which Prof. R. S. Lull discourses on "the pulse of life," attempting to link up cause and effect; "to find those forces which are responsible for the more or less rhythmic accelerations of evolution shown by the fossil record. The main cause is found to be climatic change, which in turn has as a chief controlling factor earth-shrinkage and the consequent warping of the crust." In a very fresh and suggestive way, Prof. Lull discusses some of the crises in organic evolution and their physical correlates. Thus he deals with the establishment of the lime-secreting habit, the origin of vertebrates, the emergence of terrestrial vertebrates, the evolution of the terrestrial foot, the origin of reptiles, the establishment of warm-bloodedness, the appearance of birds and mammals, man's arboreal apprenticeship, his descent from the trees, and his subsequent ascent far above the level of climbing. He submits a very striking curve to show the correspondence between the pulse of life and the heavings of the earth's broad breast. To mention a concrete factor, he shows how *aridity* probably affected the evolution of dinosaurs.

In the fifth lecture Dr. Ellsworth Huntington deals with the influence of climate on civilisation. Human progress depends, he says, upon three resources, and constitutional energy. But climate has a great influence on each of these, especially the last—a thesis which the lecture graphically illustrates. Some of the great steps in civilisation are discussed, and likewise some of the relatively recent climatic changes; the problem is to correlate the two. The author admits that, so far as inherent mental capacity is concerned, climate is in one sense a minor factor; that it is more important as regards material resources, but is far from being the sole factor; and that even when energy is considered, the effect of climate may readily be neutralised by several other factors, such as lack of resources or lack of ability. But the point to be emphasised is that climate is one of the great factors which must be reckoned with in any attempt to understand the history of civilisation.

The five essays are at a high level, the authors evidently giving of their best. There are a number of vivid illustrations, and Prof. Lull's "pulse of life" diagram makes a deep impression. We strongly recommend the book to serious students as a notable contribution to the study of the various modes of the great process of becoming.

J. A. T.

Fertilisers and Parasiticides.

Chemical Fertilisers and Parasiticides. By S. Hoare Collins. (Industrial Chemistry.) Pp. xii+273. (London: Baillière, Tindall, and Cox, 1920.) Price 10*s.* 6*d.* net.

MR. COLLINS has followed up his book on plant products by another on chemical fertilisers and parasiticides, of approximately the same size and intended for the same kind of reader. The book gives a good general account of fertilisers, and it includes numerous tables of data which will be found useful to the specialist.

Artificial fertilisers are of great interest to British chemists, as they were first used in this country and for many years the industry remained in British hands. The beginning was made in 1843, when Lawes took out his first patent for the manufacture of superphosphate; the industry developed greatly when the Chilean deposits of nitrate of soda began to be worked largely by British enterprise, and when sulphate of ammonia was recovered from coal-gas and from coke-ovens. It underwent further expansion in the 'eighties, when Wrightson showed the value of basic slag, followed in the 'nineties by the demonstrations of Dobbie, Gilchrist, Somerville, and Middleton. Only one important section has remained outside British hands—the potash fertilisers, which were formerly controlled by German interests, but now will be worked by the French companies.

Mr. Collins deals mainly with the sources and methods of manufacture of fertilisers and only incidentally with their use on the farm, giving simply such information as the ordinary salesman would need. Liberal use is made of the Rothamsted data, which supply the best demonstrations of the value of the nitrogenous and potassic fertilisers and of superphosphate. Cockle Park, Northumberland, gives the best demonstration of the value of basic slag.

Striking data are shown as to the improvement in the soil effected by the use of fertilisers. Thus at Cockle Park basic slag not only increases the yield of herbage for hay or for grazing, but also leads to an increase in the percentage of nitrogen in the soil—the result of an increased development of clover. After eleven years' treatment with basic slag the percentage of nitrogen in the soil of Tree Field, Cockle Park, has increased from 0·185 per cent. to 0·236 per cent., a gain of about 850 lb. per acre. Neither sulphate of ammonia nor nitrate of soda brought about an appreciable increase in nitrogen content.

A good but short description is given of the deposits of nitrate of soda in Chile, and also of the deposits of nitrate of potash in India. The manufacture of sulphate of ammonia is described, and the account brought up to date by reference to some of the more recent processes. In view of the importance of this industry we should have liked to see a fuller classification of methods and descriptions of typical direct, semidirect, and indirect processes: the average student of agricultural chemistry has usually no access to modern books in which these are described. An account is given of the Haber process, which will prove of interest now that the method is to be worked in this country.

Superphosphate naturally occupies considerable space, and a useful table shows the composition of the natural phosphates used as raw material. Here, too (as in the case of sulphate of ammonia), one would have liked more information from the works: more might have been told of the different types of dens in use in this country and, before the war, in Belgium. The introduction of electrical power has resulted in certain modifications in methods.

In discussing compound fertilisers no reference is made to the "base"—an organic material often acidulated, or a seed meal—used to obtain proper condition.

From the laboratory side, however, the book is very good, as would have been expected from the author, and as it has no English competitor a good reception should be assured. It contains much useful information that the student could not readily obtain elsewhere.

Lectures on Folk-lore.

Psychology and Folk-lore. By Dr. R. R. Marett. Pp. ix+275. (London: Methuen and Co., Ltd., 1920.) Price 7*s*. 6*d*. net.

CONTROVERSY is commonly interesting, if only for the fact that it appeals to a man's pugnacious instincts; and most readers like to be invited to take sides. Eight of the eleven papers in this book were originally lectures, and in most of them Dr. Marett argues vigorously against what he regards as a lifeless manner of attacking the problems of folk-lore. He states his position in the first paper, and stands by it staunchly all through the volume. To him it is perfectly clear that every scrap of folk material is ultimately due to the more or less primitive reactions of the individual mind. Now nobody can understand either the productions or the modes of operation of the human spirit, he believes, by merely looking at them from the outside. The prime problem of all folk-lore is to enter into a man's thoughts, fancies, and emotions when he is confronted by certain definable situations. But simply to study objectively the changes which folk material has undergone in the course of its history is only to gather together a lot of dry bones. The psychologist is needed to put flesh on them, and to breathe into them the breath of life. Dr. W. H. R. Rivers is thereupon, in the most pleasant manner possible, held up as an awful example of the soulless sociologist.

As to this some comments may be made. First, bones *are* needed to make a man, after all. Secondly, the distinction which Dr. Rivers has made, and quite consistently observed, between psychology and sociology is one framed specifically in the interests of method and of clear definition. It is preposterous even to hint that Dr. Rivers has urged that an objective, sociological study can cover anything like all of the ground of interest of folk-lore. He has shown, both by his words and also by his example, that the studies of psychology and sociology must proceed side by side. But he has all along been concerned to utter a much-needed protest against the fashion of mixing up psychological, sociological, biological, and ethical modes of explanation in the customary haphazard manner.

It is very interesting to consider precisely what, in Dr. Marett's opinion, psychology really has to say at present concerning the problems he discusses. The main subjects of his consideration are: War and Savagery; Primitive Values; The Psychology of Culture Contact; The Transvaluation of Culture; Origin and Validity in Religion; Magic or Religion; The Primitive Medicine Man;

and Progress in Prehistoric Times. Much of what he has to say has a metaphysical or an ethical import, and much is in the way of kindly comment upon fellow anthropologists. If, however, we search for the psychology, we find absolutely no new principle discovered, no new method of analysis proposed, nothing that definitely "sticks in the mind" as marking a clear advance. We are told in many graceful ways that the folk-lorist is to account for his materials "in terms of a self-active, self-unfolding soul"; we learn that man's emotional nature remains relatively stable, though historical conditions constantly change; that religion is a way of life, and not a set of propositions offering themselves to belief; and that suggestibility is peculiarly effective in the primitive community. In many ways the most interesting paper is the brief one on "The Transvaluation of Culture." Here a real attempt is made to analyse the forms of transference of folk materials which commonly occur as a result of the interplay of cultures. The analysis is extremely interesting, but not sufficiently developed, and this criticism applies to the whole book.

In the final paper on "Anthropology and University Education" Dr. Marett says many good things well.

The book is most pleasing to read throughout, for it could scarcely be better written. Yet it is disappointing. It is too vague and too general. Modern psychology can do more for folk-lore than Dr. Marett makes clear, and at the same time it has everything to gain and nothing to lose by a clear recognition of the equal value and necessity of an objective, sociological method of approach. F. C. BARTLETT.

Elementary Chemistry.

(1) *Intermediate Text-book of Chemistry*. By Alexander Smith. Pp. vi+520. (London: G. Bell and Sons, Ltd., 1920.) Price 8*s*. 6*d*. net.
(2) *College Text-book of Chemistry*. By William A. Noyes. Pp. viii+370. (New York: Henry Holt and Co., 1919.)

THE above titles may be misleading to English readers, the ground covered by each book being practically of Matriculation standard. The authors have, however, conveyed in addition interesting information not usually found in English text-books of similar character. The chemistry of common life and of industry receives brief treatment, and these elementary books should prove interesting to the advanced English student who, in preparing for examinations, has attained detailed knowledge of such matters as the syntheses of alkaloids and other things he is never likely to see, but has been left in ignorance of chemical processes in the body, the growth of plants, the manufacture of such things as glue, ink, bread, candles, and soap, and most of the applications of chemistry to daily life.

(1) The fundamentals of chemical theory receive careful consideration in both books; that of Prof. Smith treats in detail of the theory of electrolytic dissociation and its applications. Exception might be taken to the treatment of Avogadro's law and its relation to atomic weights. This is dealt with in the same way by both authors. The molecular weight is defined as the weight of a gaseous substance filling a volume of 22·40 litres at S.T.P., and the atomic weight of an element as the least weight found in this volume of any one of its gaseous compounds. No reason is given when the definitions are stated as to why 22·40 litres has been chosen, and it is only in the case of ideal gases that the definitions are valid. This method leads Prof. Smith to say, for instance, when describing hydrogen chloride (p. 123): "The density of the gas (weight of 1 c.c.) is 0·001628. Of more interest to the chemist is the weight of 22,400 c.c. or 22·4 liters (the gram-molecular volume), namely, 36·468 grams. This is the molecular weight of the substance. As we have seen (p. 77), it is made up of 1·008 g. of hydrogen combined with 35·46 g. of chlorine." This statement, if taken literally, is incorrect. If it is not to be taken literally, why should three places of decimals be given?

Although Scheele was the first to discover oxygen, the claims of Priestley as an independent discoverer have not so far been questioned. We now learn from Prof. Smith that Priestley is "incorrectly credited with the 'discovery' of the element," and that he described the gas as "unbreathable and noxious (poisonous)." In reality, Priestley breathed the gas himself, and recommended its use in pneumonia. The statement on the same page that oxygen was discovered by Bayen in April, 1774, is another piece of historical inaccuracy. The memoir of Bayen to which reference is doubtless made (*cf*. "Opuscules," vol. i., 1798) contains no indication that this experimenter knew that the "air" given off on heating mercuric oxide differs from common air (*ibid*., pp. 252, 312, and the editor's introduction), which is the real point at issue. Equally unfortunate is the statement that the law of conservation of energy is due to "J. R. Mayer (1842), Colding (1843), and Helmholtz (1847)," without a mention of Joule!

It seems a pity that such spelling as "woolen," "mantel," "ladeled," "marvelous," and "sulfur" should minimise the value of a text-book to English students in schools, where the rest of the curriculum has to be kept in mind by the teacher.

(2) Prof. Noyes's text-book is particularly interesting and suggestive, and very well got up, with the exception of the illustrations. The treatment is in general more concise than in the other volume, but loses nothing in the way of clearness and accuracy. It should prove a useful book to teachers in the higher forms of schools who wish to add to the interest of their lessons. The summaries at the ends of the chapters will be found useful in revision, and there are numerous suggestive questions and exercises. The elements of organic chemistry, in so far as they concern daily life, are treated in a most interesting manner, and the book should prove serviceable to students of domestic science.

It may fairly be said of both books that they are of a higher order of interest and accuracy than is usual in English books of the same standard. There is too much tendency to follow stereotyped lines in most cases in English books, which no doubt results from a desire on the part of the writers to conform to what they imagine to be useful for examinational purposes. The American writers as a whole are free from this infirmity. J. R. P.

Our Bookshelf.

Moses: The Founder of Preventive Medicine. By Capt. Percival Wood. (Biblical Studies.) Pp. xi+116. (London: S.P.C.K.; New York: The Macmillan Co., 1920.) Price 4*s*. net.

Capt. Percival Wood is, of course, not the first to recognise Moses as the founder of preventive medicine, but he has marshalled his evidence in an interesting and compelling manner in the light of modern research. Thus he ascribes the third plague that smote the Egyptians, that of lice, as the indirect result of the first plague of fouled water-supply, remarking that it does not take long in a warm climate to become infested with lice when personal hygiene is neglected. The frogs, similarly, were driven on to the land by the fouling of the water, and the myriads of dead frogs tended to breed the flies of the fourth plague. The lice and the flies and the rain, together with the destruction of their crops by locusts and hail, would likewise tend to engender epidemic disease among the famine-stricken Egyptians, and hence the culminating plague of all, that of death (the selection of the firstborn in the narrative is a dramatic detail added by a later hand).

The author passes in review the legislation on hygiene and on the control of infectious diseases, and the regulations regarding dietetics. Finally, the diet of the Israelites during their wanderings is considered. The nature of manna is problematical. There was evidently a lack of proper food, and the people probably suffered from deficiency diseases—dwarfs, "broken-footed," and "crook-backs" are mentioned, conditions that might result from rickets. As a popular and accurate description of an ancient system of hygiene this book can be cordially recommended.

R. T. H.

Structural and Field Geology: For Students of Pure and Applied Science. By Dr. James Geikie. Fourth edition, revised. Pp. xxiv+454+lxix plates. (Edinburgh: Oliver and Boyd; London: Gurney and Jackson, 1920.) Price 24*s*. net.

The demand for a fourth edition of this handsome work is sufficient testimony to its educational value. The volume reflects the lucid teaching of its author, and the present editor, Dr. Robert Campbell, has found it desirable to make alterations only in definitions and in descriptions of minerals and rocks, in accordance with current usage. Chemical formulæ, which are so useful in suggesting alliances among rock-forming minerals, are still studiously avoided, except in the case of simple oxides. This is surely now unnecessary, when some knowledge of chemistry must be required of all students of a scientific subject. Though Dr. James Geikie expressly stated that he did not write for specialists, a very little more would have held the interest of the reader.

The great aim of the book, however, is the realisation that rocks are to be studied out of doors, and that structural geology is based upon what the earth itself reveals. The selection of full-page photographic illustrations, from those of mountain-crests like Goat Fell to those of rock-surfaces as they actually are seen in Nature, calls us urgently to the field. Contrast the majestic gloom of the Torridonian and Cambrian masses in Plate lxviii with the sunlit and periwinkled rocks on the Arran shore in Plate xliii, and you perceive the artist in the field-surveyor. It is a compliment to the publishers, as well as to the memory of the author, to say that this is a gift-book of a high attraction. G. A. J. C.

Notes Pratiques sur l'Observation Visuelle des Etoiles Variables. Par Maurice E. J. Gheury de Bray. Extrait de *Ciel et Terre.* (Published by the Author: 40 Westmount Road, Eltham, S.E.9.) Price 2*s*. 4*d*. post free.

The careful and persistent observation of variable stars has risen from being the occasional hobby of a few observers to one of the most important branches of stellar physics, from which far-reaching deductions have been drawn concerning star-life, absolute magnitudes, and the structure of the universe. The number of variables is now so large that a considerable army of workers is required. The author's aim is to enlist recruits, and the field of work that he recommends is that of the long-period variables of large light-range, since visual estimates of light-difference are sufficient in these, while the Cepheids and eclipse-variables call for more refined methods and more highly trained observers. The use of charts for identifying the variable and comparison stars is explained, also the "fraction" and "step" methods of estimating light-intervals, the drawing of the light-curve, and the deduction of the epochs of maximum and minimum. The amateur who contemplates extensive work in this field is wisely recommended to join the variable star section of the British Astronomical Association; its director makes a selection of the stars needing observation, and divides the work among its members.

The physical explanation of variation lies outside the scope of the little book, but something is said about the resemblance between light-curves and the curve of sun-spot activity.

It may be noted that the author, though he writes in French, has been resident in England for many years, and is a lecturer at the Woolwich Polytechnic.

Military Psychiatry in Peace and War. By Dr. C. Stanford Read. Pp. vii + 168. (London: H. K. Lewis and Co., Ltd., 1920.) Price 10*s.* 6*d.* net.

This very interesting and valuable work deals with the mental disorders encountered in the Army in peace and war. The author was, until the time of the armistice, in charge of D block at Netley, a clearing hospital through which passed practically all the mental cases arising in the various theatres of war. He has made every use of his very exceptional opportunities, not only carrying out careful observations and records of the 3000 cases which passed through his hands, but also following up the later history of these cases after their transfer from Netley to other hospitals.

Detailed descriptions of the various forms of mental disorder are given, together with statistical facts and charts illustrating their frequency and incidence; and the military organisation developed during the war to deal with the sufferers from mental disease is interestingly described. The author belongs to the school which believes that mental disorders are essentially biogenetic, and that they are the result of a failure on the part of the organism to adapt itself to the environment in which it has to live. In this failure of adaptation an essential part is played by psychological factors, and throughout the book emphasis is laid upon their importance. A preliminary chapter on the psychology of the soldier deals with the various mental forces the action and interaction of which may lead to the outbreak of disorder.

The book is essentially a medical work, and can scarcely be recommended to those without technical knowledge of the subject, but it should prove of the utmost value to the psychiatrist, and constitutes a noteworthy addition to the medical library of the war.

Wasp Studies Afield. By P. Rau and Nellie Rau. Pp. xv + 372. (Princeton: University Press; London: Oxford University Press, 1918.) Price 8*s.* 6*d.* net.

To those surveying the boundary between instinct and reason there is no more fruitful field than the fossorial wasps, with which this book is chiefly concerned. The greater part of Mr. and Mrs. Rau's illuminating volume is descriptive of the actions of individuals; but the last chapter is an impartial judicial summary, from which we extract the following items:—(1) There are very definite and ironclad instincts. (2) Despite these instincts, which are constant in each species, there is much variation in the behaviour of the individuals. (3) There is a display of the expression of emotions. (4) There is much aptitude for learning, display of memory, profiting by experience, and what seems to us rational conduct. No reader of these pages can deny that these conclusions are abundantly justified by the facts narrated.

The most complete portion of the present work is the careful series of experiments on the "homing" of the social wasp *Polistes pallipes.* These prove beyond question that "homing" is no special faculty, but depends entirely upon experience and associative memory of surrounding objects.

A few misprints, *e.g.* "most" for "moist," p. 347, "fililng" for "filling," p. 363, and the omission of a whole line after l. 8, p. 365, require attention if further editions of this otherwise admirable work are contemplated. O. H. L.

Internal-Combustion Engines: Their Principles and Application to Automobile, Aircraft, and Marine Purposes. By Lieut.-Commr. Wallace L. Lind, U.S.N. Pp. v + 225. (Boston and London: Ginn and Co., 1920.) Price 10*s.* net.

Commander Lind addresses his preface from the United States Naval Academy at Annapolis, and the book doubtless represents the instruction there given on the subject of the internal-combustion engine. For such a purpose the book is very well suited: the theoretical work is sufficiently elementary, and the sections describing practice, although apparently slight, are just such as young cadets can grasp and appreciate, whilst realising how much there is behind to be worked at if they should think of preparing themselves for specialist courses. Such books are *sui generis*—they make little appeal to trained engineers and are too vague for university courses, but for their own special purposes they are excellent. They enable an officer to have enough general knowledge to give adequate directions to the ratings under him.

The sections devoted to motor fuels and carburettors are much fuller than the rest of the book, and are evidently written by one who has given special attention to these topics. The point of view is American, and the illustrations mainly relate to trans-Atlantic models, though reference is made to some of the more important European types—quaintly mentioned in one place as those of the "belligerent nations of Europe."

A Monograph of the British Orthoptera. By W. J. Lucas. Pp. xii+264+xxv plates. (London: The Ray Society, 1920.) Price 25*s*. net.

We heartily welcome the appearance of this useful work, for there is no doubt that a complete monograph, on any order of insects, is a great stimulus to its further study in the country concerned. Our British Orthoptera have been rather neglected in the past, but Mr. Lucas's papers, which have regularly appeared in the entomological magazines, have done good service in awakening an interest in our native species. No one, therefore, is better qualified than he is to write a Ray Society volume on the order. The book is strong on the biological side, habits, times of appearance, and distribution being adequately treated, and many interesting facts are thus collected together. We should have liked to see a fuller account of the structure of Orthoptera and some remarks on their internal organisation, but recognise that the author probably has had to limit his pages very considerably owing to the expense of publication. The earwigs are regarded as a sub-order rather than as constituting a separate order: out of twelve families only one—the Ectobiidæ—contains indigenous species. The crickets are represented by four species, including the remarkable and seldom observed mole cricket (Gryllotalpa). Only nine species of long-horned grasshoppers are known with certainty to be natives, though possibly *Phaneroptera falcata* may eventually prove to be indigenous. There seems to be but a single record of a Locustid from Scotland and, in fact, our scanty British fauna compares very unfavourably with the 160 Western European representatives of the Locustodea. Of the short-horned grasshoppers, Mr. Lucas recognises eleven species, but none are migratory locusts. The twenty-five plates illustrating the work are on the whole adequate, though we fear Nos. 7, 14, and 19 have reproduced the objects concerned on too small a scale to be of very much service. These can scarcely fail to be a source of disappointment to the author, who is an expert in the art of delineation.

A. D. I.

Grain and Chaff from an English Manor. By A. H. Savory. Pp. viii+311. (Oxford: Basil Blackwell, 1920.) Price 21*s*. net.

The village described is Aldington, in the Vale of Evesham, situated at the foot of the Cotswold Hills, and the author sets out his recollections of the people and the village life as he has known them during his residence. It is not a survey in the ordinary sense; it is rather a record of the trivial features of everyday life during the past thirty years in the village, which will no doubt prove of interest to readers who enjoy reading about country matters. The details of the farming are not described, and although figures are sometimes mentioned in connection with prices, there are no dates to give precision or to allow of any check. The book is concerned almost wholly with the village inhabitants, and its interest is literary rather than scientific.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

The British Association.

We are hoping to reply in due course to the criticisms which have been made in the columns of Nature on the present position of the British Association, but in order to do so with proper effect we are inviting from various presidents and secretaries of Sections an expression of their own views of the correspondence. We hope that it may be possible to summarise these views for the benefit of your readers without undue pressure of space. Meanwhile, it may be of interest to give at full length the following remarks from the president of Section A. It should be remembered that these were not written for publication, but, as above stated, for our consideration along with other similar documents, and publication *in extenso* has been permitted by Prof. Eddington only at our special request.

H. H. Turner.
John L. Myres.

New College, Oxford, October 10.

It is important not to confuse two distinct aims: (1) to make the proceedings less specialised, and (2) to make them more popular. I believe that in practice these two aims are often found even to be opposed. The committee of Section A has often arranged joint discussions with other Sections—a typical way of broadening our proceedings—but not in the least with the idea of attracting the public. I think the idea was that, by bringing together a number of experts with different points of view, a discussion would result which would advance science, but would necessarily be rather beyond the comprehension of most of us.

(1) I am all in favour of avoiding specialisation. The meeting of the British Association is a unique occasion in the year, and is wasted if the programme is on the same lines as those of the specialised societies which meet frequently. I would, however, deprecate the idea that the chief means of accomplishing this must necessarily be by joint meetings of Sections; this may be encouraged in moderation, especially between those Sections which (some of us think) might well never have separated. Where, as in Section A, we have a wide range of subjects the adherents of which do not usually meet together during the year, there is less need to join other Sections, and there would often be difficulty in finding a large enough room.

The drawback to a joint discussion is the multiplicity of speakers and the absence of a unifying purpose; that is how those to which I have listened strike me. If, for example, Section A should decide to give some time next year to aviation problems, I think it would be more profitable, not to arrange a joint meeting with the Engineering Section, but to invite an expert (an engineer, perhaps) to set the problems before Section A in a non-technical way. No doubt other engineers will come to hear him and make remarks on his paper; but he will have had a definite task before him to make the problems and results clear to astronomers, mathematicians, geophysicists, etc., not to argue with other experts about stalling angles and other mysterious technicalities. An illustration of this was provided this year when Prof.

Bragg addressed the Geology Section on X-rays and crystal structure; I think this was as useful as a joint meeting with Section A would have been.

(2) I very much doubt the assumption commonly made that the application of science to life and industry is what the public want to hear about. It may be good for them to hear about it, but we shall have to gild the pill with more attractive subjects, such as the age of the earth, the excavations at Cnossus, the properties of prime numbers, or Einstein. The public that we are trying to reach may be interested in the application of X-rays to atomic structure, but a paper on the latest X-ray apparatus in the hospitals would be hopelessly dull. May we not draw a moral from the fact that the best-attended Section at Cardiff seems to have been that which devoted its whole programme to pure science and scarcely touched on any industrial applications? To lay stress on the valuable material *results* of science may be the best way of touching the pockets of commercial magnates, but the British Association has also the missionary task of encouraging interest in the *methods* of science and of spreading the true scientific spirit.

The question remains: Can anything be done to set forth in a more popular way the methods of science in the towns we visit? I think anything that is done must be outside our Sectional proceedings. To popularise them would merely result in the majority of professional scientific workers staying away, leaving only those interested in scientific propaganda. Although some of our ablest men of science have the gift of being able to deliver attractive popular lectures, the majority have no special aptitude or inclination for this, and there is no reason whatever why they should. If they have trained themselves to be able to explain their work lucidly to those who have been educated to understand and criticise, they have done their part, and may leave to others the work of propaganda. We must avoid the painful spectacle of a brilliant investigator placed in an unfamiliar position before a popular audience and trying to talk down to them—a task performed much better by a man with a tenth of his knowledge, but who has practised the art of popular lecturing. Moreover, the public wants his very latest conclusions, stated without the conditions and reservations which they do not understand; and when next year he alters his opinion in the light of further advances, they will deride him and men of science generally for advertising sensationally themselves and their half-baked conclusions. It is right that we should try to make some more direct return to the public in the towns the hospitality of which we enjoy; but the difficulties and dangers are so obvious that it is desirable to proceed very cautiously.

References to the good old days of the Association, when Kelvin, Maxwell, and others would argue by the blackboard and the audience could watch new discoveries emerging, produce in my mind an effect opposite to that apparently intended. It makes me realise how greatly the Association has advanced since then. In these days, too, we have a big X, Y, Z whose views on any subject under discussion would have delighted the audience, and their presence and happy way of saying the right thing or putting an encouraging question when it was needed cannot be too highly valued. But more often X shook his head, and a whisper from the Recorder reminded me that X (a name scarcely known to the majority present) had made a life-study of the particular problem, and it was he who enlightened us. The great democracy of scientific workers is a product of the newer age, and nowhere does one feel that sense of equality and fraternity so convincingly as at the British Association.

A. S. EDDINGTON.

WITH reference to the views expressed by correspondents in NATURE as to the future of the British Association, based, it would seem, in large measure on the rather disappointing attendance at the recent meeting at Cardiff, it appears to me there were reasons for this irrespective of any decadence of the Association. May not the date being so near the height of the holiday season—viz. the end of August rather than the beginning of September, as on so many previous occasions—be accountable for the absence of some members? In these times there are more counter-attractions than formerly for scientific workers and others interested in scientific or professional subjects in connection with their own special annual gatherings. Having yielded to the claims of these, they cannot afford the time or expense of attending the British Association meeting in addition. For example, a friend of mine residing in South Wales, whom I hoped to meet at Cardiff, expressed his regret at not being able to be present, as he had to expend all his spare time during the first two weeks in August at the national Eisteddfod of Wales at Barry and the annual meeting of the Welsh Bibliographical Society also held there, and at the Cambrian Archæological Association meeting in Gower. In some instances the increased railway fares (and no reduction as formerly) and hotel and other expenses acted as deterrents, and not any falling off of interest in the Association that kept many away. The bulk of the usual attenders at the British Association belong to the class who have been most severely hit by the present hard times.

WILSON L. FOX.

Carmino, Falmouth, October 5.

Recapitulation and Descent.

THE passage entitled "Recapitulation as Proof of Descent" in Dr. Bather's "Fossils and Life" (see NATURE for September 30, p. 162) calls for critical comment, inasmuch as it is representative of inconsequent reasoning current in several text-books commonly in use among students.

If experimental breeding justified the inference that a mutant form should recapitulate the characters of its ancestral stock, the observed fact that developmental stages in the life of an organism frequently resemble adult forms which are antecedent to it in the time process would constitute a cogent consideration for regarding these antecedent forms as ancestral to such an organism. But genetic investigation does not at present lead to such a prediction, and hence it is perfectly evident that recapitulatory phenomena do not provide direct evidence for evolution. Hitherto experiment has not thrown any light on the genetic significance of recapitulation, except so far as to suggest that factorial elimination rather than any "perennial desire of youth to attain a semblance of maturity" (whatever this may mean) is the key to "the omission of some steps in the orderly process."

As Sedgwick many years ago emphasised, for the purpose of the general theory of evolution recapitulatory phenomena are of interest only as extending the law of unity of type; while the value of embryological data for phylogenetic speculations resides logically in the fact that the embryologist studies the entire sequence of structural arrangements which characterise a living organism, whereas the comparative anatomist of adult life pays attention to only one of them.

It is easy to appreciate that in a generation which was obsessed with the "immutability of species" recapitulatory phenomena would greatly influence the minds of persons otherwise slow to recognise the varying degree of similarity and dissimilarity in the combination of genetic characters which living forms exhibit; the palæontologist shows that these varying degrees of similarity and dissimilarity have been brought about by progressive differentiation in both time and place; but, as Dr. Bather rightly insists, succession (progressive differentiation) does not of necessity imply descent. The final step in the argument for evolution (*i.e.* the theory that progressive differentiation has been effected through the agency of the process of reproduction) is that organisms are known to be derived only from pre-existing organisms, and that new genetic characters are from time to time differentiated in the actual course of normal generation; hence to interpret the diversity of genetic characters in living forms *in terms of experience* it can only be inferred that such diversity has been brought about in the course of descent.

It appears to me that the paramount necessity for clear statement on the logical position of the evolution theory is: (1) To recognise that much of the reasoning employed in the past originated in the emotional atmosphere created by popular prejudice and hostility; and (2) while appreciating the fact of specificity (genetic stability), to dispense entirely with the arbitrary notions connected with the term "species" as employed by systematists. It is interesting to note in conclusion that Darwin himself regarded the facts of ontogeny as an extension of the law of unity of type rather than a contention *sui generis* in favour of the theory of evolution.

LANCELOT T. HOGBEN.

Imperial College of Science,
South Kensington, S.W.7, October 2.

I AM much obliged to you for letting me see Mr. Hogben's most interesting letter, and I thank him for emphasising the fact that the mutants of the experimental breeder do not show such recapitulatory phenomena as do the mutations of the palæontologist. Since this point was dealt with, however imperfectly, in the address, I surmise that Mr. Hogben has considered only the extract published in NATURE. His statement of "the final step in the argument for evolution" appears to me consequent, but I am not yet prepared to admit that my statement was inconsequent. Neither, I fear, is absolutely conclusive. Consequent or inconsequent, I did my best to view the problem without prejudice or emotion, but I plead guilty to some attempt at humour.

F. A. BATHER.

A Fracture-surface in Igneous Rock.

THE accompanying photograph (Fig. 1) was taken by me some years ago during the construction of the Shirawta Dam, Bombay Hydro-Electric Works, India. It shows a curious fracture surface due to a heavy gelignite detonation in finely crystalline "trap" rock. So far as I can remember, I had seen other examples of this phenomenon, but photographed this as it was a particularly good one, and I thought it would be of special interest to "elasticians."

B shows the "splash effect," having its origin at the bottom of the 1½-in. diameter vertical drill-hole A. C is a two-foot rule used to fix the scale. E is the vertical edge of a fault (or possibly a dyke) in the "trap" rock. D points to one of the faint radial "splash" lines that form a sort of aurora about the explosion centre A.

It will be noticed that the "splash" at B looks like the fluting of a large fossil. The Deccan "trap," however, is an igneous rock, and, of course, has no fossils in it. Tentative explanations that may be advanced are (*a*) that the pressure at A was so enormous at the moment of detonation that an actual flow of the rock took place; (*b*) that the fluted surface is the result of unequal stress distribution due to "interference" between waves reflected from the three reflecting surfaces. These surfaces are: (1) The rock surface some 10 ft. to 20 ft. above and parallel to the foot-rule C. (2) The face of the fault E. (3) The original face of the cutting lying in a plane parallel to the plane of the paper and, at the most, 2 ft. in a line normal to the paper from the points A and B.

The distance to the original face before the blast would not be more than 6 in. to 1 ft. from the top of the drill-hole shown. The hole was drilled in the side of the rock cutting having a "batter" of about one in five, at the stage when the photograph was taken. The drill-hole A would probably be about 3½ ft. deep, and the point A about 5 ft. above the floor of the cutting.

It should also be mentioned that the site of this explosion was the side of a rock cutting about half a mile long, with level bottom leading to the Shirawta-Walwhan tunnel. The rock cut at the shallow end would be about 3 ft. deep, and at the tunnel end about 40 ft.; its top width was 20 ft.,

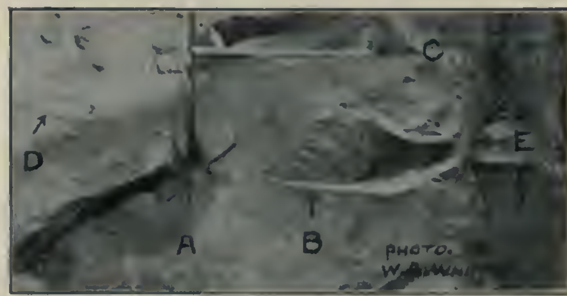

FIG. 1.—Splash-like fracture-surface due to gelignite explosion in rock A, base of 1½" diameter drill-hole and origin of explosion; B, fluted "splash effect"; C, 2-ft. rule, to fix scale; D, one of a number of radial "splash" lines.

and its width at the bottom was, at that date, from 5 ft. to 10 ft.

Samples of rock similar to that blown away from A were weighed, and their specific gravity worked out at between 2·720 and 2·752 (taking the weight of a cubic foot of water as 62·5 lb.).

(Prof. B. Hopkinson calculated that the maximum pressure at the face of an explosion of 1 oz. of guncotton is of the order 100 tons per sq. in., and that this maximum is attained in 1/400,000th of a second.)

Since writing the above, it has been suggested that the phenomenon is a large example of conchoidal fracture. In any case, I think the photograph will be of interest to readers of NATURE.

W. BEVAN WHITNEY.

Meadow House, Layters Way,
Gerrards Cross, Bucks, September 19.

A Visual Illusion.

THE visual illusion described by Mr. Turner in NATURE of October 7, p. 180, may be seen very well by looking steadfastly at a long luggage train as in, for example, counting the trucks at about 100 yards distance. Immediately after the train has passed, the embankment appears to slide along in the opposite direction.

A. E. BOYCOTT.

17 Loom Lane, Radlett, October 10.

The Behaviour of Time Fuzes.

By PROF. A. V. HILL, F.R.S.

THE time fuze is a device for exploding a shell at any desired interval after it is fired. Before the late war the time fuze was used mainly with shrapnel shell, to burst the shell in the air and so propel the bullets down on to the objective. For this purpose the ordinary "powder-train" fuze gave—considering its simplicity—remarkably good and consistent results; at any rate so good that no serious impetus had been given to a proper scientific study of its properties under a variety of conditions. The development of anti-aircraft gunnery, however, in which the employment of a percussion fuze was useless, and in which the target moved so fast that no preliminary "ranging" on it was possible, not only required a much greater reliance to be placed on the accuracy of the time fuze, but also subjected it to much more severe conditions than had ever occurred before. The conditions referred to were those set up by variations of velocity, air pressure, spin, and temperature. Moreover, the enormous quantity of powder suddenly required for military use made it difficult for the manufacturers to produce it with the same quality and consistency as of old. All these factors led to a series of extraordinary difficulties in connection with time fuzes, such as irregular burning and a wholesale failure to burn at all; these difficulties were never completely overcome in practice, but they stimulated a much fuller investigation of the factors governing them, and have resulted in a far greater understanding of the physical behaviour of fuzes. As so often happens in the history of knowledge, urgent practical need led to scientific discovery.

The powder train fuze consists of one or more rings of highly compressed gunpowder forced into a metal groove. The ring is fired by a detonator at the moment the shell is accelerated in the barrel, and after a certain amount of it, adjustable beforehand, has been burnt it ignites a pellet which fires a second detonator which explodes the charge. The "fuze-setting," determining the length of powder to be burnt, and therefore the time of burning, is adjusted by turning the ring round an axis parallel to that of the shell. The gases produced by the combustion escape from a hole in the fuze, usually at the side, but sometimes in the nose. The position of this hole is of great importance, as will be shown below.

In a fuze at rest the time of burning is proportional to the length of powder burnt, and it has long been known that the rate of burning is a function of the atmospheric pressure. Very exact relations have been established between the pressure and the rate of burning under a variety of conditions, though their explanation is by no means clear, and some very interesting problems in the physical chemistry of combustion are provided by them. The gunpowder, of course, burns inside a closed ring, supplying its own oxygen, so that the effect of pressure is simply one of pressure as such. In the fuze fired in a shell from a gun the time of burning is by no means proportional to the length of powder burnt; usually the rate of burning is greatest at first (*i.e.* when the velocity of the shell is highest), decreasing gradually as the shell slows up until a more or less constant value is attained. In some fuzes, however, the rate of burning is least at first, increasing later on. Indeed, in some cases the same fuze may show one phenomenon when fired in one shell, and the opposite when fired in another. This complex relation between length of powder burnt and time of burning has received a complete explanation in the theory of the "dynamic pressure" at the escape holes. When a body moves rapidly through the air the pressure at any given point varies with the speed, and at any given speed varies from point to point of the shell. So completely does this theory explain the phenomena that an observed relation between "fuze-setting" and time of burning has been used even in the converse way to determine the pressure at a variety of points on the head of a shell moving at various speeds up to 1600 ft. per second. It is possible, of course, for the "dynamic pressure" to be a negative one—*i.e.* to be a "suction"—in which case, if it be sufficiently large, the powder may refuse to burn at all, and the shell will be "blind." This will be the case if the escape hole be too far back from the nose of the shell, or be under the lee of a projection on the fuze. It is necessary to take particular account of these factors in the design of the fuze body.

The scientific development of the theory of fuze burning dates largely from a trial carried out in the winter of 1916–17 at Portsmouth, in which a large number of fuzes of the same type and "lot" was fired to various heights up to 20,000 ft. in exactly similar shells, from five different 3-in. guns differing only in respect of their muzzle velocities. The results were very peculiar, and at first almost incredible; it was found that the effect of a given fall of atmospheric pressure in the upper air, whether in lengthening the time of burning or in producing a liability to irregularity and "blinds," was far greater in the case of a shell fired from a high-velocity gun than it was in the case of one fired from a low-velocity gun—quite independently of what its actual velocity might be at the moment considered. A given fuze in a given shell, moving at a given velocity, at a given reduced atmospheric pressure in the upper air, might be expected to burn at a definite fixed rate. It did not! The rate of burning depended on the previous history of the shell—viz. on the velocity with which it had left the muzzle of the gun. What effect could this previous velocity have left upon it? The mystery was so complete that one was clearly on the eve of a discovery. Various theories were put forward to account for it, such, for example, as that the shell "yawed" from its path to a degree varying from gun to gun, the "yaw" being supposed to affect the pressure at the escape holes, and therewith the time of burning. The true explanation, however, proved to be the hitherto unsuspected effect of "spin"—*i.e.* the angular velocity of the shell about its axis, and this factor has since proved practically the most important one in the behaviour of a powder train fuze. The shell, in order to secure stability in its flight, is given a high angular velocity by the rifling of the gun working on the copper driving-band. In all the guns employed (varying in velocity from 900 f.s. to 2500 f.s.) the twist of the rifling was 1 turn in 30 calibres—*i.e.* in 30 times 3 in. or $7\frac{1}{2}$ ft. This gave angular velocities varying from 7200 to 20,000 revolutions per minute in the five guns. The angular velocity of a shell falls off comparatively slowly in flight, so that it could be regarded as approximately constant along the trajectory of each gun. The peculiar differences observed in the gun trials could be explained only as an effect of spin, and it was clearly necessary to carry out spinning trials on fuzes "at rest"—*i.e.* without forward velocity—to see if the effect of spin could be isolated. Such trials were carried out at speeds up to 30,000 r.p.m., and an enormous effect of spin was established. It was possible to double the time of burning of a fuze, or even to make it cease burning altogether, merely by spinning it. The effects of a fall of pressure also were exaggerated by spin, as was shown in the laboratory at University College, by spinning a fuze under reduced pressure.

The explanation of this effect of spin is interesting. It could not be due to any "dynamic pressure" effect at the escape holes, or to a centrifugal effect on the gases in the groove; these were investigated and found to be far too small. The real explanation is the centrifugal effect on the slag produced by the gunpowder in its combustion. When the spin is high the gunpowder, warmed, softened, and just ignited by the combustion of the previous layer, is "spun" outwards to the outer edge of the groove before it has had time properly to burn and to ignite the next layer; consequently, combustion is slower, and may fail altogether. The absence of any effect of spin in the case of a special powder giving no slag, as well as the fact that "blind" fuzes are found to have failed first on the *inside* edge of the ring, make it clear that the centrifugal effect on the slag is the prime cause of the trouble. At 30,000 r.p.m., a spin reached in fuzes fired from small guns, it is almost impossible to attain any accuracy at all. The rapid increase of fuze-trouble with spin is due to the fact that the centrifugal effect varies as the *square* of the spin.

One obvious means of avoiding the excessive effect of spin was to reduce the rifling of the gun and therewith the rotation of the shell. The possibility of doing this is strictly limited, as with too low a spin the shell becomes unstable. Two similar guns were rifled respectively 1 turn in 30 and 1 turn in 40 calibres, and in all respects the fuzes fired from the latter were found to behave more satisfactorily, thus confirming the results and predictions of laboratory trials. All similar guns were provided thereafter with the smaller rifling, with good effects.

Another factor affecting the behaviour of fuzes is their temperature. This effect, also previously unknown, is a smaller one, but by no means negligible. A fuze burns more quickly at a higher temperature, and allowance must be made for this in accurate firing. A curious phenomenon arises in connection with this. It was usual to test a fuze at rest as well as in the gun, and in the case of some long-burning fuzes at rest the fuze heats itself by its own combustion to such an extent that its time of burning is seriously decreased. This "self-heating" effect does not occur in a fuze fired from a gun, which is cooled by its passage through the air. Consequently, for accurate comparison with gun trials the fuze fired at rest must be cooled while it burns—*e.g.* by subjecting it to a rapid spray of water. This was actually done in later trials, the fuze being rotated in a closed box at any required spin and pressure, and subjected the while to a rapid jet of water to ensure the constancy of its temperature.

We may summarise as follows: The rate of burning of a fuze is a function of the total pressure at its escape holes, which is made up of the atmospheric pressure A and some function $f(v/V)$ of v its velocity and V the velocity of sound. It is a function also of the spin S and of the temperature T. Expressed mathematically, the rate of burning is equal to $F[\{A+\rho f(v/V)\}, S, T]$, where F is some complicated function of the three variables. It is easy to see that fuzes are likely to cause trouble when subjected to conditions, as they were in the late war, far exceeding in severity any under which they had previously been used; and to foretell that in the next war—if there be one—reliance will be placed mainly on clockwork fuzes unaffected by these various factors.

The Iridescent Colours of Insects.[1]

By H. Onslow.

III.—Selective Metallic Reflection.

In the two preceding articles various insects have been described and illustrated, which owe their principal iridescent effects to the colours of "thin plates" and to the diffraction of ribbed structures or "gratings." However, more than one physicist of repute has stated that most insect colours are due to selective metallic reflection. The arguments against this theory, as applied to scales, were considered in the first article; briefly, they are due to the facts that both reflected

[1] Continued from p. 183.

and transmitted colours disappear when scales are immersed in fluids of a highly refractive index, and that all colours vanish when scales are subjected to pressure, as could scarcely be the case if the colours were due to some molecular structure, such as a film of aniline dye.

Now in the case of scaleless beetles and in many other iridescent structures, including bees and dragon-flies with bright, metallic wings, (1) the colour does not disappear on exerting pressure; (2) the reflected colour does not disappear on immersion in fluids of high refractive index, even when penetration is facilitated by a vacuum; and (3) the transmitted colour, so far as this can be seen, also persists. It is worth noting that the data which Michelson relies on to show the similarity in the behaviour of polarised light, when reflected from iridescent insect structures and films of aniline dye, fit the wing-cases of beetles much more closely than they do the wings of butterflies or the feathers of birds.

Sections *1* and 2 of Fig. 1 show typical iridescent wing-cases. Section *1* is that of the common green Rose Beetle (*Cetonia aurata*) and section 2 that of a beetle with a peculiar sheen (*Anomala dussumieri*), due to the numerous dome-shaped protuberances, *b*, seen in section. The surface of the chitin is protected by a thin cuticle, *c*, 0·5μ thick, but there appears to be no structure likely to produce colour. It is clear that this film cannot cause the colour, because the wing must have a protective sheath of some sort, otherwise the colour would disappear as soon as the surface came into optical contact with a refractive fluid. Consequently it is very important to determine exactly at what depth the colour-producing layer is situated, in order to decide whether there is room for an adequate structure to exist above it.

For this purpose a wing-case was carefully polished under the microscope with a paste of the finest carborundum and cedar-wood oil. On removing the surface-layer, a very remarkable change of colour was observed to have taken place. Sections were cut from suitable portions of the polished area, the exact colour and position of which could be determined. A composite picture of three different sections is shown in *3* (Fig. 1). To the extreme right of section *o* the cuticle, *c*, is untouched, but further on it is partly removed, and the lowest point seems to have been reached near *b*, in section *n*. Somewhere here the colour changes to magenta, but as soon as the irregular dark line dividing the cuticle from the lower layers is passed all colour vanishes, and the black chitin is exposed, as at *a*, in section *m*. Thus it appears that this line running underneath the cuticle is the seat of the colour-producing layer, and its extreme depth is about 0·5μ below the surface. This figure, which was obtained with the microscope, was checked by an indirect method of measurement, and the two results were found to agree with sufficient accuracy.

There appears to be a choice between two alternatives: (1) the colour may be due to a single thin film, which must lie under a protective sheath of some description, or (2) it may be produced by a layer having properties similar to an aniline dye. Although it is possible to show that under suitable conditions single films could, by interference, produce colours as bright as those shown by beetles, the second alternative appears the more probable. This is principally because of the exceedingly small distance between the surface of the wing-case and the lowest limit of the colour-producing layer. Within the space of 0·5μ, room

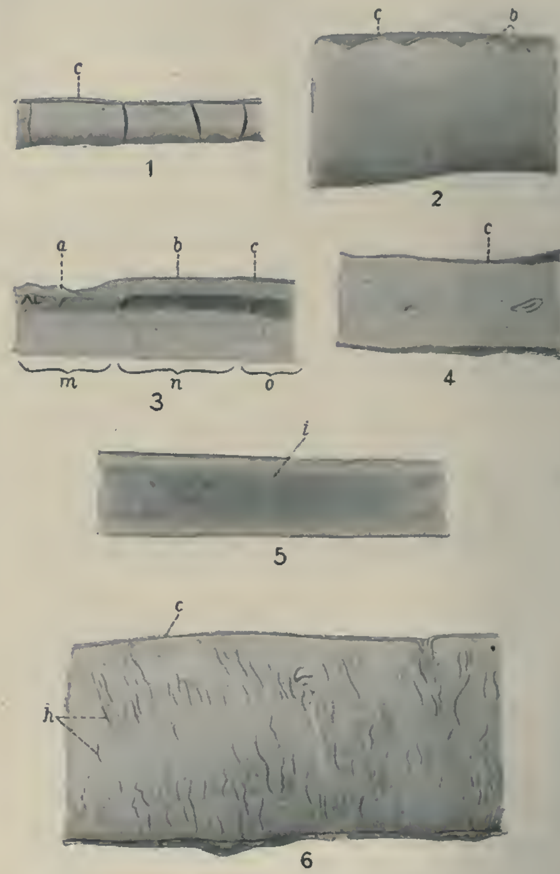

FIG. 1.

1, Surface layer, or "*Emailschicht*," of *Cetonia aurata*. *c*, surface cuticle.

2, Wing-case of *Anomala dussumieri*. *c*, cuticle; *b*, knobs or bosses.

3, Composite section of *Plusiotis resplendens* after polishing. *m*, underlying chitin; *n*, magenta portion: *o*, unpolished portion; *a*, black chitin; *b*, magenta film; *c*, surface cuticle.

4, Wing-case of *Thlaspidomorpha balyii*. *c*, surface cuticle.

5, Hair of *Chrysochloris aurea*. *i*, imbricated scales.

6, Scutum of tick *Amblyomma hebraeum*. *c*, surface cuticle; *h*, black hair-like canals filled with air.

These sections were all drawn to the scale μ=1 mm. with Zeiss 2 mm. apochromat, N.A. 1·4, and Comp. Oc.

must be made both for the protective cuticle and for the thin film itself. This might, indeed, be just possible, but is unlikely, because of the peculiar sequence of the colours caused by reducing the thickness of the iridescent film in polishing.

This appearance is difficult to describe, and must be seen to be appreciated fully. On polishing the brilliant gold beetle *Plusiotis resplendens*, no effect is at first seen, except perhaps a slight dulling of the lustre. The golden surface, scarred and scratched by the polishing crystals, remains unaltered for a period, which appears to depend on the thickness of the cuticle. Then, at a certain depth, the gold is suddenly replaced by a metallic magenta, and where this is seen to shine through a very thin film of gold, a silvery-blue effect is produced. On continuing to polish, the magenta rapidly disappears, revealing the black underlying chitin. These changes may be closely imitated by gently polishing a thin film of gold deposited electrolytically on copper. Similar effects are also seen when a copper sheet is gently heated in the steam-oven until films of oxide are formed. It is worth mentioning that Mallock has shown, by means of polishing experiments, that the coloured films of steel oxide are not due to interference in the manner usually supposed.

In the case of these beetles it may be objected that the colour of a thin film *would* change if its thickness were reduced by polishing in the above way. The change of colour, however, would be gradual, and not abrupt as is the case. Moreover, the sequence of colours would be different from that which actually occurs, as, for instance, when bluish-green and green wing-cases change to crimson or scarlet.

Some Iridescent Colours which Depend on Moisture.

The small beetles, forming the group known as Tortoise Beetles, throw considerable light on the question of surface colours by their behaviour in various fluids. Many of these beetles are golden when alive, or when preserved in spirit, but brown when dry. The colour, however, returns on soaking them in alcohol, but not in all other organic fluids. Section 4 (Fig. 1) is cut from a wing-case which has a thin cuticle, *c*, and is in other respects almost exactly like that of an ordinary scaleless beetle that retains its colour after drying. Moreover, the colour does not disappear under pressure, but here the resemblance ceases, for, curiously enough, the golden glitter remains, even after the cuticle has been polished away, so long as the surface is kept moist. In fact, almost the whole wing-case may be ground away before the metallic lustre disappears. It is obvious, from this curious behaviour, that the whole thickness of the surface layer of chitin is concerned, when in a moist condition, in reflecting a lustre, somewhat in the same way as pebbles on a beach glitter in the sunshine when washed by an advancing wave. Even vertical cracks in the chitin are seen to have golden sides. The reason for this behaviour is clear. When dry, aqueous alcohol and certain fluids can penetrate the cuticle, but other organic fluids cannot. The colour does not return immediately after immersing the beetle, but it must soak, because the protecting cuticle is pervious only with some difficulty. For the same reason, once it is wet, the colour takes some time to disappear, because the cuticle prevents the moisture from evaporating, as it must no doubt do when the beetle is alive. The fact that the whole thickness of the chitin layer reflects metallic colour suggests that, in scaleless beetles, colour may be due to a skin of chitin having the same properties as that of the Tortoise Beetles, but with the surface so polished that moisture is not necessary for the development of the colour.

Some of the most interesting beetles of this group are those which, though colourless when dry, develop a brilliant iridescence on being moistened with a wet brush. There is a remarkable bug with these properties, named *Pycanum rubens*, which is a bright apple-green when alive or in spirit, but a dull purple-brown when dry. Experiments were made in various fluids, and it was found that in alcohol, which was completely dehydrated by metallic calcium, immersion produced no colour. But the slightest trace of water caused the colour to return, and dilute acid had the effect of making it more or less permanent. Pressure experiments showed that there was no surface colour due to a molecular structure, because the colour completely disappeared, to return again as soon as the pressure was removed, just as the colours of thin films should do. These and other observations made it probable that the colour arose in a thin membrane with, like gelatin, a specific power of absorbing water, but not other organic solvents. When dry, the membrane must be too uneven to cause regular reflection, but as soon as it is swollen with water it can give the colours of thin films.

The third example of this type of iridescence was found in certain metallic ticks first described by Prof. Nuttall. When dry, they are a dull ochre, and in most anhydrous fluids a matt silver, like freshly cut aluminium, but in aqueous fluids they show bright metallic colours, both green and red. Reference to a section of the scutum, 6 (Fig. 1), shows that a protective cuticle, *c*, covers a thick layer of chitin interpenetrated by innumerable tiny air-canals, *h*. It is probable that, when dry, the white light reflected from this air renders all structural colours invisible; but when an aqueous fluid, which can penetrate the cuticle, fills these canals, the dark background produced clearly shows up the colours which may, or may not, be due to an absorbent membrane, as in the case of *P. rubens*.

In the course of these investigations many other very interesting iridescent structures were examined, for a description of which there is here no space. Many of these revealed no adequate colour-producing structure, and they present a most interesting field for further research. Among the most striking objects are the green metallic wings of certain bees and dragon-flies, such as some of the Carpenter bees, and *Neurobasis chinensis*. These very brilliant and thin structures behaved in many ways like the wing-cases of scaleless beetles. There are also the iridescent eyes of many Diptera, and the amazing iridescent hairs of a mammal, the Cape Golden Mole, *Chrysochloris aurea*, 5 (Fig. 1), showing the fine imbricated scales, *i*. In addition there are the brilliant *setae* of the "sea-mouse," a marine worm (*Aphrodite aculeata*). In plants not many iridescent structures are found, with the exception of the beautiful Pteridophyte, *Selaginella Wildenovii*, which glistens with a very strong blue and purple metallic sheen.

Obituary.

ARTHUR SIDGWICK AS NATURALIST.

THE admirable notice of the late Arthur Sidgwick in the *Times* of September 28 describes him as "naturalist," as well as "scholar" and "politician." It is a true and just description. The love of natural history developed early, and was always one of the strong and essential elements in his intellectual life.

Sidgwick was twenty-seven, and had been a master at his old school—Rugby—for three years, when Wallace's article "On Mimicry and other Protective Resemblances among Animals" appeared in the *Westminster Review* for July, 1867, and it had the same effect upon him as, in its later form, reprinted in the "Essays on Natural Selection," it had on the present writer. A few months after reading it, Sidgwick, on November 9, read his paper "On Protective Resemblances among Insects" before the Rugby School Natural History Society (pp. 23–26 of the report for 1867), in which he not only gave an admirable review of the article, but was also able to draw on his own past experience as a naturalist for illustrations. There is one slip in his reference to Wallace's account of Bates's epoch-making paper, for he spoke of the Heliconidæ and their Leptalis mimics as "white," whereas they are brightly coloured, while the Leptalis, abandoning an ancestral white, have become brightly coloured also.

Among Sidgwick's original observations in the paper, the following are quoted by Wallace in his revised essay (p. 45 of the 1875 edition):—

> I myself have more than once mistaken *Cilix compressa*, a little white and grey moth, for a piece of bird's dung dropped upon a leaf, and *vice versa* the dung for the moth. *Bryophila glandifera* and *perla* are the very image of the mortar walls on which they rest; and only this summer, in Switzerland, I amused myself for some time in watching a moth, probably *Larentia tripunctaria*, fluttering about quite close to me, and then alighting on a wall of the stone of the district, which it so exactly matched as to be quite invisible a couple of yards off.

Observations of this kind were far from well known in those days, only a few years after the appearance of the "Origin of Species."

Sidgwick was a man of strong opinions; what he believed he believed intensely. Yet, with all this, he was exceptionally modest. I recall a later paper of his on the same subject as the earlier, read before the recently established Oxfordshire Natural History Society. In the discussion some criticisms were passed upon the relative value of the destructive agencies of which he had spoken. He accepted the remarks of much younger members with perfect kindliness, and ended by saying that he hoped "to do better next time."

These memories lead naturally to thoughts of his simplicity, and with it his delightful and infectious boyishness. One came in to ask for his ever-ready help in coining some scientific term, and found him testing his latest toy, a little typewriter, and then everything must give way to a race between the player and the writer—the latter much handicapped by the banging of the machine; or a simple form of billiard table had displaced the heaps of books, and a game must be played; or a chunk of marzipan emerged and must be shared.

Sidgwick's sympathy with the aims of science in university life was not bounded by his love of natural history. In the conflicts which often arose, and were bound to arise, between the old, which is really modern, and the new, which is a return to the ancient ways, Sidgwick always supported science. I never knew an exception in the years when we were closely associated.

Among the notices and memories of Arthur Sidgwick I have seen, there has been no reference to the two volumes of "School Homilies," addressed, from 1870 onwards, to the boys in Canon J. M. Wilson's House at Rugby. The addresses deal, as Canon Wilson says in his introduction, "with apparently commonplace subjects, but they lifted every subject out of the commonplace." They should be read by everyone who wishes to know the man and all that he stood for.

E. B. P.

BY the death of M. LOUIS DUCOS DU HAURON we lose one of the foremost pioneers in the photography of colour. M. du Hauron was born on December 8, 1837, and died on August 31 last. *La Nature* of September 25 publishes a portrait taken in 1877, and the *British Journal of Photography*, Colour Supplement, of October 1 gives the portrait by which he is generally known, taken evidently some years after the other, and a useful chronology of his work. It seems that he began the study of luminous sensations in 1859, and that by 1862 he had worked out a method of colour photography by means of three colour filters and complementary printing; but his chief contributions to the subject are contained in two small volumes, which, unfortunately, are now very rare—"Les Couleurs en Photographie: Solution du Problème," published in 1869, and "Les Couleurs en Photographie et en particulier l'Héliochromie au Charbon," published in the following year. In these publications he enunciated the principles of three-colour photography, including even the present "screen-plate" processes, such as the autochrome, Paget, and others. It was impossible then to carry out these processes satisfactorily, because it was not until 1873 that Vogel discovered the possibility of sensitising plates for colour, and it was still later that gelatine plates were commercially manufactured. M. du Hauron was a pioneer also in motion photography, stereoscopic work, and other matters.

THE death occurred on September 27 of DR. D. LLOYD ROBERTS at the age of eighty-four years. Dr. Lloyd Roberts was born in 1835 at Stockport, and received his medical education at the old Manchester Royal School of Medicine, and afterwards in the hospitals of London and Paris. In 1857 he obtained the diplomas of M.R.C.S. (Eng.) and L.S.A.; two years later he received the degree of M.D. from the University of St. Andrews, and became F.R.C.P. (Lond.) in 1878. During this period he was appointed honorary physician to St. Mary's Hospital for Women and Children, a post which he retained until his death. In 1902 Dr. Lloyd Roberts was president of the section of obstetrics of the British Medical Association, and he was also a member of numerous other medical societies. He contributed many papers to medical journals, and as early as 1876 published "The Practice of Midwifery," the fourth edition of which was issued in 1896. In other spheres he will be remembered as the editor of Sir Thomas Browne's "Religio Medici," first published in 1892, and for a short pamphlet read in 1914 before the Dante Society of Manchester on "The Scientific Knowledge of Dante."

MANY geologists in this country will regret to learn that their old friend, SVEN LEONHARD TÖRNQUIST, the doyen of Swedish geologists, died at Lund on September 6 from hæmorrhage of the brain. Törnquist's work on graptolites is familiar to all who deal with Lower Palæozoic palæontology and stratigraphy, and his writings on the geology of the beautiful Siljan district in Dalecarlia and on the relations of the Leptæna limestone have been a guide to many visitors for more than half a century. Papers were received from him up to the present year, for he still retained vigour of mind and body.

WE much regret to announce the death on October 1, at sixty-eight years of age, of PROF. ITALO GIGLIOLI, professor of agricultural chemistry in the Royal University of Pisa, Italy. Also of PROF. YVES DELAGE, professor of zoology at the Sorbonne, Paris, and member of the Academies of Science and Medicine, on October 8, at sixty-six years of age.

THE death is announced, on October 4, at sixty-five years of age, of DR. MAX MARGULES, secretary of the Zentralanstalt für Meteorologie und Geodynamik at Vienna.

Notes.

ON Monday, October 11, H.R.H. the Prince of Wales returned from his seven months' tour of the West Indies and our Colonies in the Pacific Ocean. When the Prince set out on March 17 it was intended that he should pay a visit to the Indian Empire, but this has been deferred until next year out of consideration for his health. However, during his long journey he has had an opportunity of seeing some of the diverse lands and peoples which go to make up the British Empire. To the credit of science, it can be put on record that during the whole course of the tour the Prince was never for a day out of touch with London. Telegraphy and "wireless" have made continual communication possible. It is also noteworthy that, in spite of encountering bad weather, the *Renown* kept to her time-table with great accuracy; marine engineers are to be congratulated on this remarkable achievement. The experience which the Prince has gained is invaluable to one who will some day have the task of ruling the Empire. His Majesty the King has voiced this sentiment in a letter which was addressed to the Secretary of State for the Colonies for transmission to the Governors-General and Governors of the Colonies which have been visited. He says: "May such mutual intercourse create fresh ties of confidence and devotion between the Throne and the generations, present and future, of these great lands, and thus promote the unity, strength, and prosperity of the Empire." The experience is also of importance in the study of problems of the moment, of reconstruction and all that it entails. That the Prince himself appreciates this is apparent from the following words from his reply to the address of welcome made by the Mayor of Portsmouth: "We are still, I fear, only at the beginning of the labours which are necessary to restore our credit and prosperity after the prolonged strain of the war, and I am deeply interested in our problems of reconstruction, which all parts of the nation must pull together to solve."

IN 1901 the German troops in Peking removed a number of old astronomical instruments from the city wall, and they were sent to Germany and erected at Potsdam. By the Treaty of Peace it was stipulated that they were to be restored. Col. Yate, hon. secretary of the Central Asian Society, announces in the *Times* of October 8 that twenty huge cases containing these instruments have arrived in China. Six of the instruments were constructed in 1673 by Father Verbiest, S.J., and one in 1715 by Father Kegler, S.J., and these are all copies of Tycho Brahe's instruments. To make room for them on top of the wall Verbiest removed thence two old instruments, which afterwards were put up in a court at the foot of the wall, where they stood until 1901. These two instruments had been erected in 1279 by the astronomer Ko-Show-

King from designs by the Persian astronomer Gemal-ed-din, and they are of considerable interest, being the earliest known equatorials. It is curious that Marco Polo never mentioned them, though he was at Peking when they were erected; but excellent pictures of them are given in Yule's "Book of Ser Marco Polo," third edition, vol. i., pp. 448 *sqq*.

THE *Morning Post* of October 7 contains the interesting announcement that next Saturday, October 16, a memorial tablet to Descartes is to be unveiled at Amsterdam. The tablet has been placed on No. 6 Westermarkt, the house where Descartes resided during the summer of 1634. Prior to the unveiling there will be a gathering at the University, at which M. René Doumic, director of the *Revue des Deux Mondes*, and Prof. Cohen, formerly of Amsterdam University, will speak. Descartes, who was born in 1596, came of a well-to-do family of Touraine, and was always in easy circumstances. Educated by the Jesuits, then the rising schoolmasters of Europe, he afterwards continued his mathematical studies with Mersenne and Mydorge. At the age of twenty he adopted the military profession, and saw active service with the Bavarian Army during the early part of the Thirty Years' War. The first ideas of his philosophy and of his analytical geometry are said to have come to him in three dreams on the night of November 10, 1619, when bivouacked at Neuberg, on the Danube. Descartes resigned his commission in the spring of 1621, spent the next few years in study and travel, and in 1629 settled in Holland, where he found the freedom from distraction necessary to the production of his great works. Twenty years later he accepted the invitation of Queen Christina to take up his residence in Sweden. The Queen wished to found an academy with Descartes at its head, but all her designs were frustrated by his death at Stockholm on February 11, 1650. Buried first in Sweden, his remains were afterwards taken to Paris, where after several removals they now rest in the church of St. Germain-des-Prés.

REPRESENTATIONS have on several occasions been made to the Government of the Union of South Africa, in particular by the council of the Royal Anthropological Institute, that it was urgently necessary that the study of the native population should be officially recognised and placed upon a properly constituted basis. The Government has, consequently, been much impressed by the great and urgent need for the scientific investigation of the ethnology, history and languages, customs, and religious beliefs of the Bantu race, and has now agreed to render substantial aid in the establishment of a school of Bantu life and language. Several university centres in the Union have from time to time asked for assistance to establish chairs in these subjects, but, acting on the recommendation of a Departmental Committee, the Government has decided that, for the present at any rate, it is desirable to concentrate such work. A school will, therefore, be established in connection with the University of Cape Town. A representative Committee, which includes the Secretary for Native Affairs, is now sitting to discuss the general scheme. It is anticipated that professors of Bantu ethnology and Bantu language will be appointed as a nucleus of the school at an early date.

SIR FRANK W. DYSON, Astronomer Royal, has been elected an honorary member of the American Astronomical Society. Prof. Kapteyn, of Groningen, is the only other living honorary member of this society.

UNUSUALLY warm and fine weather prevailed over England during the five days from October 5 to 9. On each day the sheltered thermometer at Greenwich was 70° or above, and the highest reading was 73° on October 5. On two of the nights the minimum temperature was 57°, and on two other nights 56°. The mean maximum temperature for the five days was 71° and the mean minimum 55°, both of which were 10° above the normal. There have been slightly warmer days at Greenwich very occasionally in the early part of October, the highest temperatures recorded since 1841 being 81° on October 4, 1859, and 79° on October 4, 1886. During the last eighty years there have been only twenty-two Octobers with a temperature so high as 70°, and only two previous Octobers, 1859 and 1869, with five consecutive days of 70° or above. In recent years the warmest weather in October occurred in 1908, when the thermometer exceeded 75° on each of the first four days, but the nights were much cooler than this year. Prior to the present year the thermometer at Greenwich has only once touched 70° in October during the previous nine years.

ON Thursday, October 7, at University College, London, Sir W. H. Bragg delivered a public introductory lecture on the history of science. A course of lectures on the general history and development of science was first introduced into the college curriculum last session. The course was specially required for students training for the new diploma in journalism instituted by the University of London. It was felt, however, that facilities for the study of the subject might be welcomed by a much wider circle, considering the important part played by scientific ideas and methods in the advancement of civilisation. Moreover, since the subject is obviously vast, it was deemed desirable to provide, so far as possible, courses on the history of special sciences in addition to the course on the general history of science. Accordingly, the number of lectures and lecturers for the new session has been increased considerably. A general introductory course will be given by Dr. A. Wolf; a course on the biological and medical sciences by Dr. C. Singer (first and second terms), and by Prof. W. M. Bayliss and Prof. J. P. Hill (third term); a course on Egyptian science by Prof. Flinders Petrie; a course on the history of astronomy by Prof. L. N. G. Filon; Mr. L. T. Wren will lecture on the history of mathematics (second term); and during the third term Sir W. H. Bragg, Prof. Garwood, Mr. Orson Wood, and others will deal with the more important developments of physical science during the nineteenth century. It is hoped that in due course there will be established at the college a flourishing school in the history of science in which teaching and research will both receive due attention.

Prof. F. Francis, professor of chemistry in the University of Bristol, has been elected a corresponding member of the Belgian Royal Academy of Medicine.

A Ramsay memorial fellowship of the value of 300*l.* a year for three years has been founded by subscriptions received from the Swiss Government and from Swiss donors through the good offices of Prof. Ph. A. Guye, of Geneva. The first fellow to be elected is M. Etienne Roux, of Vich (Vaud), Switzerland, who has decided to work in the laboratories of Prof. W. H. Perkin at Oxford.

Viscount Haldane, O.M., will give an address on "The Industrial Question" to members of the Institute of Industrial Administration at the Central Hall, Westminster, on Saturday, October 23, at 8 p.m. Sir Lynden Macassey will take the chair. Invitation tickets may be obtained from the hon. secretary, Mr. E. T. Elbourne, 110 Victoria Street, S.W.1.

The Thomas Vicary lecture of the Royal College of Surgeons of England will be delivered on Thursday, November 11, at 5 o'clock, by Sir D'Arcy Power, who will take as his subject "The Education of a Surgeon under Thomas Vicary." The Bradshaw lecture of the same institution will be delivered at 5 o'clock on Monday, December 6, by Sir Berkeley Moynihan. The subject will be "The Surgery of the Diseases of the Spleen."

The annual May lecture of the Institute of Metals for 1921 is to be delivered on May 4 next by Prof. T. Turner. The annual general meeting of the institute is to take place on March 9 and 10, 1921, at the Institution of Mechanical Engineers. The May lecture will be given in the same hall. An interesting programme of lectures in connection with the local sections of the institute at Birmingham, Glasgow, and Sheffield has been prepared. Among the lecturers are Lord Weir of Eastwood, Dr. W. Rosenhain, and Prof. C. H. Desch.

With reference to the letter which appeared in Nature for August 5 last, p. 709, on the loss of fragrance in musk plants, it is interesting to note that Mrs. W. H. Cope, joint secretary of the Birmingham Field Naturalists' Club, has observed a similar absence of perfume from all the musk plants which she purchased in the open flower market this year. The observation was corroborated by other members of the club, and a suggestion was made that the loss of odour was due to the atrophy of scent-producing cells consequent on a change in the type of insects by which fertilisation was effected.

The Rev. S. Claude Tickell informs us that a movement is being promoted at Santa Barbara, California, whereby all egg-collectors are invited to accumulate local eggs, with a view to world-wide exchange with other collectors. We agree with Mr. Tickell that the movement is crude and cruel, and that "recollection" by drawing should be substituted for "collection" and the consequent molestation of wild birds. For this purpose Mr. Tickell advocates the establishment of complete, permanent collections of birds' eggs in the museums of the larger towns so that children might have opportunities of drawing and memorising the eggs; this might do away with the thousands of incomplete and transitory collections which exist at the present time.

It is a very charming and modest account of Winchester College Museum that the Rev. S. A. McDowall contributes to the October issue of the *Museums Journal*. We do not gather from it how much use is made even of the Greek and Roman collections in actual school work, but that the boys out of school-hours are encouraged to take part in curatorial activities appears from the statement that "a collection of local spiders owes its existence to the keenness of a boy still in the school." By leading boys on in this way to take the first steps in research, school museums and school natural history societies may do more than professed classes. Two excellent photographs of the interior of the museum, by a boy in the school, are reproduced as one of the plates. Among much else that is of interest in the varied contents we note a discussion by Mr. E. E. Lowe of the Public Libraries Act of 1919 and its effect on the future policy of (municipal) museums.

In the *Geographical Review* for April–June (vol. ix., No. 4) Dr. V. E. Shelford has a long article, well annotated with bibliographical references, on the aquatic biological resources of the United States. While much attention has been given to water-supply for domestic purposes, to water-power, and to the disposal of sewage, Dr. Shelford points out that other aspects of aquatic resources are more or less neglected. These include, in addition to marine fisheries, fresh-water fisheries and mussels, the provision of fish-ways in rivers, the breeding of edible frogs and turtles in swamps and lake-margins, the preservation of insect-destroying birds, and the cultivation of certain aquatic plants of economic value. Dr. Shelford further makes a special plea for the preservation of large swamp areas unless their presence can be shown to be actively detrimental to health. The pollution of rivers and coastal waters is condemned as harmful to natural resources.

The Congo Expedition of the American Museum of Natural History is the subject of a short article, accompanied by a map, in the Bulletin of the museum (vol. xxxix., p. xv.). The expedition, which spent more than six years in the Congo, returned to New York in 1915 with some 20,000 vertebrate and more than 100,000 invertebrate zoological specimens, besides large collections in anthropology and botany. The district explored was in the north-east of the Belgian Congo, from the Aruwimi River to the head-waters of the Welle River. The leader of the expedition was Mr. H. Lang, who was assisted by Mr. J. P. Chapin. It is proposed to publish the results in four series: scientific papers, which will be collected into twelve volumes after appearance in the Bulletin; special memoirs; three ethnological albums; and the narrative of the expedition. As some acknowledgment of the generous co-operation of the Belgian Government in the work of the expedition, it has been decided to present a duplicate set of the collection to the Congo Museum at Tervueren, near Brussels.

THE hall illustrating the "Age of Man" in the American Museum of Natural History, New York, is now approaching completion, and Prof. H. F. Osborn gives some account of it in the journal of the museum, *Natural History* (vol. xx., No. 3). Besides the collection of plaster casts and specimens, there are beautiful wall-paintings by Mr. C. R. Knight, representing scenes in the life of the various races of prehistoric man and of the large mammals by which they were surrounded in different parts of the world. There are also hypothetical bust-restorations of Pithecanthropus, Eoanthropus, Neanderthal man, and Crô-Magnon man; while a completely restored figure of Neanderthal man is now being attempted. Critics may be disposed to think that existing evidence is too slender to justify some of the conclusions about man's ancestry which the exhibition suggests, but there can be no doubt that so attractive a presentation of the subject will stimulate wide interest in it in America.

WE have recently received vol. xvii., part v., of the Annals of the South African Museum, containing two systematic papers, one on the Crustacea, the other on the spiders, of South Africa. The former is the sixth contribution by Mr. K. H. Barnard on the crustacean fauna of South Africa, and deals with further additions to the list of marine Isopoda; 73 species are here recorded, 45 being described as new. The list of South African marine Isopoda now includes about 170 species.

IN his presidential address to the Eugenics Association of America (*Scientific Monthly*, September) Dr. Stewart Paton pleads for a more definite and exact knowledge of man in order that the study of eugenics may be directed on sound lines, and especially points out the importance of the study of the personality—the reactions of the human machine as a whole to the conditions actually met with in life. A body of investigators specially trained in the difficult art of studying the personality—which cannot be judged only from the point of view of the physiologist or psychologist—is essential for future progress.

MISS E. A. FRASER has investigated the pronephros and the early development of the mesonephros in the cat (*Journal of Anatomy*, vol. liv., part iv., July, 1920), and finds that the embryonic excretory system of this animal is one continuous organ, the degenerate anterior end passing posteriorly into the fully developed mesonephros. A pronephric ridge is developed as a thickening of the somatic wall of the intermediate cell-mass. During the formation of this ridge and immediately lateral to it a series of cœlomic chambers becomes cut off from the general body-cavity, each chamber communicating with the body-cavity by a narrow passage. Such chambers do not appear to have been observed previously in a mammal, and it is suggested that they represent vestigial pronephric chambers, each with a peritoneal funnel. They soon undergo a change, and from the region of the eleventh somite backwards they close off from the body-cavity and form an almost solid longitudinal cord, which later becomes divided into a series of vesicles, the central cavity of each of which arises secondarily. Though it is difficult to demonstrate that the longitudinal cord of tissue in which the vesicles arise is actually derived from the pronephric chambers, this interpretation seems to be the correct one. If so, then the pronephric chambers are homologous with the Malpighian capsules.

DURING the course of recent ecological work on the Irish coast—near Dublin and in Galway Bay—collections were made of the mites (Acarina) occurring in the inter-tidal area, and Mr. J. N. Halbert has described the material in a paper published in the Proceedings of the Royal Irish Academy (vol. xxxv., B7, 1920). The species dealt with, which are such as can be reasonably considered as habitual denizens of the inter-tidal area, do not apparently exhibit any striking modifications to suit them for a semi-aquatic life, *e.g.* the breathing organs present no modification. The majority of the species possess, in common with many purely terrestrial species, a smooth, shining epidermis or a covering of hairs, which serves to protect the surface of the mite from becoming wetted. The usual habitat of these mites is in sheltered places—crevices, rock-fissures, and under embedded stones—such as have been for long undisturbed, and where air is imprisoned during high tides. Higher up on the shore, at about high-water mark, a few species have succeeded in establishing themselves where they are only occasionally wetted or sprayed. The zonal distribution of the inter-tidal mites is shown in a table, from which it is seen that below the upper zone, named the orange lichen zone (from the occurrence there of Physcia, Lecanora, etc.), the number of species becomes suddenly much less. The list contains seventy-seven species, twelve of which are new, and a new genus is described.

CLOUDINESS in the United States is the subject of an article by Prof. R. De C. Ward in the *Geographical Review* for April–June (vol. ix., No. 4, 1920). The article contains a useful bibliography of the subject and a new map showing the mean annual cloudiness. The regions of maximum cloudiness appear to be the Great Lakes and the St. Lawrence valley in the east and the northern part of the Pacific Coast in the west. The desert regions in the south-west naturally experience least cloud. Over most of the country the difference between the amount of cloud in the cloudiest and in the least cloudy months is only 10–20 per cent., but in the regions of maximum cloudiness it is 30 per cent. or more, and in the western plateau region it is more than 40 per cent.

THE microscopic examination of the structure of metals and other substances by the aid of light reflected from a polished and etched surface has proved of such great value that Mr. F. E. Wright, of the Geophysical Laboratory of the Carnegie Institution, Washington, has gone carefully into the question as to how far it might be possible by such an examination in polarised light to determine the optical constants of the materials present in the surface. The result of his work is published in No. 7 of the Proceedings of the American Philosophical Society for the current year. Unfortunately, Mr. Wright finds that these constants cannot be satisfactorily found by the method, although there is no difficulty in ascertaining whether the substances seen are crystalline or not by the rotation of the plane of polarisation of plane polarised incident light. Tests of colour, hardness, and behaviour under the action of solvents still remain the most trustworthy for the determination of the substances exposed at the surface.

AMONG the announcements of forthcoming books just issued by the Oxford University Press is one which should appeal especially to readers of NATURE, viz. vol. ii. of "Studies in the History and Method of Science," edited by Dr. C. Singer. The work will contain the following contributions:—Greek Biology and its Relation to the Rise of Modern Biology, Dr. C. Singer; Medieval Astronomy, Dr. J. L. E. Dreyer; Leonardo as Anatomist, H. Hopstock; Science and Hypothesis, Dr. F. C. S. Schiller; The Asclepiadæ and the Priests of Asclepius, E. T. Withington; History of Anatomical Injections, F. J. Cole; The Scientific Works of Galileo, J. J. Fahie; Unity in Modern Scientific Thought, F. S. Marvin; Four Armenian Tracts on the Structure of the Human Body, F. C. Conybeare; Roger Bacon and the State of Science in the Thirteenth Century, R. Steele; A History of Palæobotany, Dr. E. N. A. Arber; Science and Metaphysics, J. W. Jenkinson; and Archimedes' Principle of the Balance and some Criticisms upon it, J. M. Child. The same publishers also promise "A History of Greek Mathematics," by Sir Thomas Heath, in two volumes.

SIR ISAAC PITMAN AND SONS, LTD., have in preparation a new series of Technical Primers, the aim of which is to present a sound technical survey of fundamental facts, principles, equipment, and practice in volumes covering ultimately all phases and branches of technology. The earliest volumes will deal with Continuous-Current Armature Winding, Belts for Power Transmission, Municipal Engineering, Water-Power Engineering, Photographic Technique, Foundrywork, Pattern-Making, Hydro-Electric Developments, The Electric Furnace, Small Single-Phase Transformers, Pneumatic Conveying, The Electrification of Railways, and The Steam Locomotive.

THE Cambridge Pocket Diary for the academic year 1920–21 has been issued by the Cambridge University Press, price 3*s*. In addition to the information usually found in diaries, a complete list of University officials, dates of examinations and of meetings of officials, and local information, such as Cambridge telephone numbers and the train service to London and to Oxford, are included in this convenient little book.

THE United States Coast and Geodetic Survey has published a short list (No. 109) of its publications since January 1, 1914, which is supplied free of charge to those interested. The list includes papers in geodesy, magnetism, cartography, and hydrography.

Our Astronomical Column.

THE ITALIAN ASTRONOMICAL SOCIETY.—This society is commencing the publication of the third series of its Memoirs. Vol. i., No. 1, has just appeared, and contains several papers of interest. The Rev. J. G. Hagen writes on the galaxy and the "Via Nubila"—a name that he suggests for a stream of nebulæ, both luminous and dark, having its maximum density in the well-known nebulous region round the galactic North Pole. G. Armellini contributes a paper on the gravitational potential of the galaxy, and endeavours to explain certain small anomalies in the motion of the planets Saturn and Neptune by stellar perturbations. It is, however, fairly clear that on any reasonable assumption of the mass of the stellar system its differential action within the planetary family must be wholly inappreciable. A. Bemporad publishes a series of comparisons of 32 Geminorum with the neighbouring stars ξ and ϵ Geminorum, made with a wedge photometer between December and March last. It is concluded that the magnitude of 32 Geminorum varies between 6·5 and 7·2 in a period of 2·43 days; the light-curve is not given, but it is stated to be "of the usual type of short-period variables, with a pronounced secondary maximum." E. Bianchi notes that the minor planet (44) Nysa varied in light with a range of half a magnitude in a period of thirty-six days; these observations were made in March and April, 1913. On the other hand, observations in 1920 indicate the much shorter period of $3\frac{1}{4}$ hours; this is presumably an effect of rotation, in which case the monthly variation previously observed needs some other explanation. Other papers deal with the giant and dwarf stars (G. Zappa); measures of the sun's diameter, which appear to show some variation in the value in the course of the sun-spot cycle (A. Prosperi); and stellar spectra with an objective prism (G. Abetti).

THE COLOUR OF NEBULOUS STARS.—Sir W. Herschel discovered 130 years ago that certain stars were surrounded by nebulous envelopes, and made the correct deduction that the latter were gaseous, not stellar. These objects play an important part in theories of cosmogony, and deserve careful study. The *Astrophysical Journal* for July contains a paper by F. H. Seares and E. P. Hubble which establishes the interesting fact that these stars are redder by about one colour-class than would be expected from their spectral type. This was first noted visually by Hubble in one or two cases; a systematic campaign was therefore planned with the Mount Wilson 60-in. reflector, using the method of exposure ratios. About fifty stars were examined, being roughly half of the known objects of this type. Their spectra are mainly of type B, with a few early A's, one Oe5, and one G5. Check stars were photographed at the same altitude to determine the plate constants. The stars mainly lie in two groups, and the mean excess of colour-class for these groups is 1·28 and 0·88. In a few cases where the effect does not appear it is stated that the visual aspect suggests that the star is not really in the nebula, but accidentally projected upon it.

There is a discussion of possible explanations; the most straightforward is that the red colour is produced by molecular scattering in the nebulous envelope. Fluorescence in the nebula near the star's surface is also suggested; alternatively, that the presence of the envelope may have an influence on the star's constitution. It is noted that if the envelope were composed of particles above a certain size, general, and not differential, absorption would result, so that this may explain the non-occurrence of the phenomenon in a few cases.

Our Conceptions of the Processes of Heredity.*

By MISS E. R. SAUNDERS, F.L.S.

I.

BY the term "inheritance" we are accustomed to signify the obvious fact of the resemblance displayed by all living organisms between offspring and parents, as the direct outcome of the contributions received from the two sides of the pedigree at fertilisation; to indicate, in fact, owing to lack of knowledge of the workings of the hereditary process, merely the *visible* consequence—the final result of a chain of events. Now, however, that we have made a beginning in our analysis of the stages which culminate in the appearance of any character, a certain looseness becomes apparent in our ordinary use of the word "heredity," covering as it does the two concomitant essentials, genetic potentiality and somatic expression—a looseness which may lead us into the paradoxical statement that inheritance is wanting in a case in which, nevertheless, the evidence shows that the genetic constitution of the children is precisely like that of the parents. When we say that a character is inherited no ambiguity is involved, because the appearance of the character entails the inheritance of the genetic potentiality. But when a character is stated not to be inherited it is not thereby indicated whether this result is due to environmental conditions, to genetic constitution, or to both causes combined. That we are now able in some measure to analyse the genetic potentialities of the individual is due to one of those far-reaching discoveries which change our whole outlook, and bring immediately in their train a rapidly increasing array of new facts, falling at once into line with our new conceptions, or by some orderly and constant discrepancy pointing a fresh direction for attack.

The earliest attempts to frame some general law which would co-ordinate and explain the observed facts of inheritance were those of Galton and Pearson. These schemes, however, take no account of the physiological nature of this as of all other processes in the living organism. They have, in consequence, failed to bring us nearer to our goal—a fuller comprehension of the workings of the hereditary mechanism. Progress in this direction has resulted from the method of inquiry which deals with the unit in place of the mass. The revelation came with the opening of the present century, for in 1900 was announced the rediscovery of Mendel's work, actually given to the world thirty-five years earlier, but at the time leaving no impress upon scientific thought. It chanced that in each pair of characters selected by Mendel for experiment the opposites are related to each other in the following simple manner: An individual which had received both allelomorphs, one from either parent, exhibited one of the two characteristics, hence called the dominant, to the exclusion of the other. Among the offspring of such an individual both characteristics appeared, the dominant in some, its opposite, the recessive, in others, in the proportion approximately of three to one. This is the result which might be expected from random pairing in fertilisation of two opposites, where the manifestation in the zygote of the one completely masks the presence of the other. As workers along Mendelian lines increased and the field of inquiry widened, it soon, however, became apparent that the dominant-recessive relationship is not of universal occurrence. It likewise became clear that the simple ratios which obtained in Mendel's experiments are not characteristic of every case. Mendel's own results were all, as it happened, explicable on the supposition that the two alternative forms of each character were dependent on a *single* element or factor. We now know, however, that many characters are not controlled by one single factor, but by two or more. One of the most familiar instances of the two-factor character is the appearance of the colouring matter anthocyanin in the petals of plants such as the stock and sweet pea. Our proof that two factors (at least) are here involved is obtained when we find that two true breeding forms devoid of colour yield coloured offspring when mated together. In this case the two complementary factors are carried, one by each of the two crossed forms. When both factors meet in the one individual, colour is developed. We have in such cases the solution of the familiar, but previously unexplained, phenomenon of reversion. Confirmatory evidence is afforded when among the offspring of such cross-bred individuals we find the simple 3 to 1 ratio of the one-factor difference replaced by a ratio of 9 to 7. Similarly, we deduce from a ratio of 27 to 37 that three factors are concerned, from a ratio of 81 to 175 four factors, and so on. The occurrence of these higher ratios proves that the hereditary process follows the same course whatever the number of factors controlling the character in question.

And here I may pause to dwell for a moment upon a point of which it is well that we should remind ourselves from time to time, since, though tacitly recognised, it finds no explicit expression in our ordinary representation of genetic relations. The method of factorial analysis based on the results of inter-breeding enables us to ascertain the least possible number of genetic factors concerned in controlling a particular somatic character, but what the total of such factors actually is we cannot tell, since our only criterion is the number by which the forms we employ are found to differ. How many may be common to these forms remains unknown. In illustration I may take the case of surface character in the genera Lychnis and Matthiola. In *Lychnis vespertina* the type form is hairy; in the variety *glabra*, recessive to the type, hairs are entirely lacking. Here all glabrous individuals have so far proved to be similar in constitution, and when bred with the type give a 3 to 1 ratio in F_2 (Report to the Evolution Committee, Royal Society, i., 1902). We speak of hairiness in this case, therefore, as being a one-factor character. In the case of *Matthiola incana* v. *glabra*, of which many strains are in cultivation, it so happened that the commercial material originally employed in these investigations contained all except one of the factors since identified as present in the type and essential to the manifestation of hairiness. Hence it appeared at first that here also hairiness must be controlled, as in Lychnis, by a single factor. But further experiment revealed the fact that though the total number of factors contained in these glabrous forms was the same, the respective factorial combinations were not identical. By inter-breeding these and other strains obtained later, hairy F_1 cross-breds were produced giving ratios in F_2 which proved that at least four distinct factors are concerned (Proc. Roy. Soc., B, vol. lxxxv., 1912). Whereas, then, the glabrous appearance in Lychnis always indicates the loss (if for convenience we may so represent the nature of the recessive condition) *of*

* From the opening address of the President of Section K (Botany) delivered at the Cardiff meeting of the British Association on August 24.

one and the same factor, analysis in the stock shows that the glabrous condition results if *any factor out of a group of four* is represented by its recessive allelomorph. Hence we describe hairiness in the latter case as a four-factor character.

It will be apparent from the cases cited that we cannot infer from the genetic analysis of one type that the factorial relations involved are the same for the corresponding character in another. That this should be so in wholly unrelated plants is not, perhaps, surprising, but we find it to be true also where the nature of the characteristic and the relationship of the types might have led us to expect uniformity. This is well seen in the case of a morphological feature distinctive of the N.O. Gramineæ. The leaf is normally ligulate, but individuals are occasionally met with in which the ligule is wanting. In these plants, as a consequence, the leaf-blade stands nearly erect instead of spreading out horizontally. Nilsson-Ehle ("Kreuzungsuntersuchungen an Hafer und Weizen," Lund, 1909) discovered that in oats there are at least four, and possibly five, distinct factors determining ligule formation, all with equal potentialities in this direction. Hence, only when the complete series is lacking is the ligule wanting. In mixed families the proportion of ligulate to non-ligulate individuals depends upon the number of these ligule-producing factors contained in the dominant parent. Emerson (Annual Report of the Agricultural Experiment Station of the University of Nebraska, 1912) found, on the other hand, that in maize mixed families showed constantly a 3 to 1 ratio, indicating the existence of only one controlling factor.

From time to time the objection has been raised that the Mendelian type of inheritance is not exhibited in the case of specific characters. That no such sharp line of distinction can be drawn between the behaviour of varietal and specific features has been repeatedly demonstrated. As a case in point, and one of the earliest in which clear proof of Mendelian segregation was obtained, we may instance Datura. The two forms, *D. stramonium* and *D. tatula*, are ranked by all systematists as distinct species. Among other specific differences is the flower colour. The one form has purple flowers, the other pure white. In the case of both species a variety *inermis* is known in which the prickles characteristic of the fruit in the type are wanting. It has been found that in whatever way the two pairs of opposite characters are combined in a cross between the species, the F_2 generation is mixed, comprising the four possible combinations in the proportions which we should expect in the case of two independently inherited pairs of characters, when each pair of opposites shows the dominant-recessive relation. Segregation is as sharp and clean in the specific character flower colour as in the varietal character of the fruit.

Among the latest additions to the list of specific hybrids showing Mendelian inheritance, those occurring in the genus Salix are of special interest, since heretofore the data available had been interpreted as conflicting with the Mendelian conception. The recent observations of Heribert-Nilsson ("Experimentelle Studien über Variabilität, Spaltung, Artbildung und Evolution in der Gattung Salix," 1918) show that those characters which are regarded by systematists as constituting the most distinctive marks of the species are referable to an extremely simple factorial system, and that the factors mendelise in the ordinary way. Furthermore, these specific-character factors control not only the large constant *morphological features*, but also *fundamental reactions* such as those determining the condition of physiological equilibrium and vitality in general. In so far as any distinction can be drawn between the behaviour of factors determining the varietal as opposed to the specific characters of the systematist, Heribert-Nilsson concludes that the former are more localised in their action, while the latter produce more diffuse results, which may affect almost all the organs and functions of the individual, and thus bring about striking alterations in the general appearance. *S. caprea*, for example, is regarded as the reaction product of two distinct factors which together control the leaf-breadth character, and also affect, each separately and in a different way, leaf form, leaf colour, height, and the periodicity of certain phases. We cannot, however, draw a hard-and-fast line between the two categories. The factor controlling a varietal characteristic often produces effects in different parts of the plant. For example, the factors which lead to the production of a coloured flower no doubt also in certain cases cause the tinging seen in the vegetative organs, and affect the colour of the seed. Heribert-Nilsson suggests that fertility between species is a matter of close similarity in genotypic (factorial) constitution rather than of outward morphological resemblance. Forms sundered by the systematist on the ground of gross differences in certain anatomical features may prove to be more akin, more compatible in constitution, than others held to be more nearly related because the differentiating factors happen to control less conspicuous features.

Turning to the consideration of the more complex types of inheritance already referred to, we find numerous instances where a somatic character shows a certain degree of coupling or linkage with another perhaps wholly unrelated character. This phenomenon becomes still further complicated when, as is now known to occur fairly frequently, somatic characters are linked also with the sex character. The results of such linkages appear in the altered proportions in which the various combinations of the several characters appear on cross-breeding. Linkage of somatic characters can be readily demonstrated in the garden stock. Some strains have flowers with deeply coloured sap, *e.g.* full red or purple; others are of a pale shade, such as a light purple or flesh colour. In most commercial strains the "eye" of the flower is white owing to absence of colour in the plastids, but in some the plastids are cream-coloured, causing the sap colour to appear of a much richer hue and giving a cream "eye." Cream plastid colour is recessive to white, and the deep sap colours are recessive to the pale. When a cream-eyed strain lacking the pale factor is bred with a white-eyed plant of some pale shade, the four possible combinations appear in F_2, but not, as we should expect in the case of two independently inherited one-factor characters, in the proportions 9 : 3 : 3 : 1, with the double recessive as the least abundant of the four forms. We find instead that the double dominant and the double recessive are both in excess of expectation, the latter being more abundant than either of the combinations of one dominant character with one recessive. The two forms which preponderate are those which exhibit the combinations seen in the parents, the two smaller categories are those representing the new combinations of one paternal with one maternal characteristic. In the sweet pea several characters are linked in this manner, viz. flower colour with pollen shape, flower colour with form of standard, pollen shape with form of standard, colour of leaf axil with functioning capacity of the anthers. If in these cases the cross happens to be made in such a way that the two dominant characters are brought in one from each side of the pedigree instead of both being contributed by one parent, we get again a result in which the two parental combinations occur more frequently, the two recombinations or "cross-overs" less often than we should expect. In the first case the two characters appear to hang together in descent to a certain extent, but not completely; in the latter, similarly to repel each other.

This type of relationship has been found to be of very general occurrence. The linked characters do not otherwise appear to be connected in any way that we can trace, and we therefore conclude that the explanation must be sought in the mechanism of distribution. Two main theories having this fundamental principle as their basis, but otherwise distinct, have been put forward, and are usually referred to as the *reduplication* and the *chromosome* view respectively. The reduplication view, proposed by Bateson and Punnett (Proc. Roy. Soc., 1911), rests on the idea that segregation of factors need not necessarily occur simultaneously at a particular cell-division. The number of divisions following the segregation of some factors being assumed to be greater than those occurring in the case of others, there would naturally result a larger number of gametes carrying some factorial combinations and fewer carrying others. If this differential process is conceived as occurring in an orderly manner it would enable us to account for the facts observed. It has, however, to be said that we cannot say *why* segregation should be successive, nor at what moments, on this view, it must be presumed to occur. On the other hand, the conceptions embodied in the chromosome hypothesis as formulated by Morgan and his fellow-workers ("The Mechanism of Mendelian Heredity" (Morgan, Sturtevant, Muller, and Bridges), 1915) are, in these respects, quite precise. They are built around one cardinal event in the life-cycle of animals and plants (some of the lowest forms excepted), viz. the peculiar type of cell-division at which the number of chromosomes is reduced to half that to be found during the period of the life-cycle extending backwards from this moment to the previous act of fertilisation. In the large number of cases already investigated the chromosome number has been found, as a rule, to be the same at each division of the somatic cells. We can, in fact, take it as established that it is ordinarily constant for the species.

These observations lend strong support to the view that the chromosomes are persistent structures—that is to say, that the chromatin tangle of the resting nucleus, whether actually composed of one continuous thread or not, becomes resolved into separate chromosomes at corresponding loci at each successive mitosis. The reduction from the diploid to the haploid number, according to the more generally accepted interpretation of the appearances during the meiotic phase, is due to the adhering together in pairs of homologous chromosomes, each member of the set originally received from one parent lying alongside and in close contact with its mate received from the other. Later, these bivalent chromosomes are resolved into their components so that the two groups destined one for either pole consist of whole dissimilar chromosomes, which then proceed to divide again longitudinally to furnish equivalent half chromosomes to each of the daughter nuclei.

The obvious close parallel between the behaviour of the chromosomes—their pairing and separation—and that of Mendelian allelomorphs which similarly show pairing and segregation, first led to the suggestion that the factors controlling somatic characters are located in these structures. The ingenious extension of this view which has been elaborated by Morgan and his co-workers presumes the arrangement of the factors in linear series after the manner of the visible chromomeres—the beadlike elements which can be seen in many organisms to compose the chromatin structure—each factor and its opposite occupying corresponding loci in homologous chromosomes. From this conception follows the important corollary of the segregation of the factors during the process of formation and subsequent resolution of the bivalent chromosomes formed at the reduction division. We should suppose, according to Morgan, in the case of characters showing *independent* inheritance and giving identical Mendelian ratios whichever way the mating is made and however the factorial combination is brought about, that the factors controlling the several characters are located in *different* chromosomes. Thus in the case of Datura already mentioned the two factors affecting sap-colour and prickliness respectively would be presumed to be located so far apart in the resting chromatin thread that when separation into chromosomes takes place they become distributed to different members. Where unrelated characters show a *linked* inheritance the factors concerned are held, on the other hand, to lie so near together that they are always located in one and the same chromosome. Furthermore—and here we come to the most debatable of the assumptions in Morgan's theory—when the bivalent chromosome composed of a maternal and a paternal component gives rise at the reduction division to two single dissimilar chromosomes, these new chromosomes do not always represent the original intact maternal and paternal components. It has been observed in many forms that the bivalent structure has the appearance of a twisted double thread.

Already in 1909 cytological study of the salamander had led Janssen (*La Cellule*, xxv.) to conclude that fusion might take place at the crossing points, so that when the twin members ultimately draw apart each is composed of alternate portions of the original pair. Morgan explains the breeding results obtained with Drosophila by a somewhat similar hypothesis. He also conceives that in the process of separation of the twin lengths of chromatin cleavage between the two is not always clean, portions of the one becoming interchanged with corresponding segments of the other, so that both daughter chromosomes are made up of complementary sections of the maternal and paternal members of the duplex chromosome. On the main issue, however, both schemes are in accord. A physical basis for the phenomenon of linkage is found in the presumed nature and behaviour of the chromosomes, viz. their colloidal consistency, their adhesion after pairing at the points of contact when in the twisted condition, and their consequent failure to separate cleanly before undergoing the succeeding division.

According to Morgan, the frequency of separation of linked characters is a measure of the distance apart in the chromosome of the loci for the factors concerned, and it becomes possible to map their position in the chromosome relatively to one another. In this attempt to find in cytological happenings a basis for the observed facts of inheritance, our conception of the material unit in the sorting-out process has been pushed beyond the germ-cell, and even the entire chromosome, to the component sections and particles of the latter structure.

To substantiate the "chromosome" view the primary requisite was to obtain proof that a particular character is associated with a particular chromosome. With this object in view it was sought to discover a type in which individual chromosomes could be identified. Several observers working on different animals found that a particular chromosome differing in form from the rest could be traced at the maturation division, and that this chromosome was always associated with the sex-character in the following manner. The female possessed an even number of chromosomes so that each egg received an identical number, including this particular sex-chromosome. The male contained an uneven number, having one fewer than the female, with the result that half the sperms received the same number as the egg including the sex-chromosome, and half were deficient in this particular chromosome. Eggs fertilised with sperms containing the full number of chromosomes developed into females, while those fertilised with sperms lacking this distinctive chromosome produced males. Morgan made the further discovery in the fruit-fly, *Drosophila ampelophila*, that certain factors controlling various somatic characters were located in the sex-chromosome. The inheritance of these characters and of sex evidently went together. The sperms of Drosophila are therefore conceived as of two kinds, one containing the same sex-chromosome as the eggs, the so-called X chromosome, and the other a mate of a different nature, the Y chromosome, which appears to be inert and unable to carry the dominant allelomorphs.

Instances of sex-linked inheritance are now known in many animals, some of which are strictly comparable with Drosophila; others follow the same general principle, but have the relations of the sexes reversed, as exemplified by the moth Abraxas, which has been worked out by Doncaster (Rep. Evolution Committee, iv., 1908), whose sudden death we have had so recently to deplore. Here the female is the heterozygous sex, and contains the dummy mate of the sex-chromosome.

(*To be continued.*)

The Department of Scientific and Industrial Research.

By J. W. WILLIAMSON.

THE Report of the Committee of the Privy Council for Scientific and Industrial Research for the year 1919–20[1] is of great interest to all those who are watching with sympathetic anxiety the attempt, embodied in the Department of Scientific and Industrial Research, to secure greater and better organised State aid for scientific research without subjecting the research worker to such Governmental control as would stifle his spirit and energies. The present report is the Committee's fifth annual report, and the Report of the Advisory Council which is subjoined, before proceeding to record the past year's work, takes the occasion to give a brief survey of its labours during the past five years.

The Government has entrusted to the Department during the past year new responsibilities. The Geological Survey and Museum of Practical Geology were transferred to the Department on November 1 last, and a Geological Survey Board has been appointed under the chairmanship of Sir Francis Ogilvie. At the beginning of this year the Cabinet decided that means should be adopted so to organise the scientific work that was needed for the fighting Services as to avoid unnecessary overlapping, to secure the utmost economy of *personnel* and equipment, to facilitate the interchange of scientific knowledge and experience between all the Departments concerned, and to provide a single direction and financial control for all work of a fundamental nature of civilian as well as military interest. It directed that the Department should establish a series of co-ordinating Boards, and that these Boards should include technical representatives of each of the fighting Services and of such civilian Departments as might be materially interested in their work, as well as independent men of science. Three Boards, one for chemistry, one for physics, and one for engineering, have been established, and these, with the existing Radio Research Board, form the nucleus of the scheme. These new arrangements are, obviously, an attempt to apply the principles of the co-operative conduct of research to Government Departments, and as the Advisory Council points out: "If firms competing with each other for existence can combine, as they have done, for their common benefit, it ought not to be more difficult for the members of a national service to do so merely because they are attached to different Departments of the Government."

[1] Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1919–20. (Cmd. 905.) Pp. 120. (London: H.M. Stationery Office.) Price 1s. net.

The review of the past five years' work of the Department is a satisfying and promising record. The programme, it is explained, falls under four main heads: (1) The encouragement of the individual research worker, particularly in pure science; (2) the organisation of national industries into co-operative research associations; (3) the direction and co-ordination of research for national purposes; and (4) the aiding of suitable researches undertaken by scientific and professional societies and organisations.

Since the establishment of the Department, 136 maintenance grants have been made to students and 89 to independent workers, while 48 grants have been made to provide professors with research assistants of scientific standing. During the four academic years in which grants could be made, approximately 50,000*l*. was distributed in grants of the various kinds referred to, and it is anticipated that during the next academic year the distribution will amount to about 45,000*l*. The great majority of the grants have been made for work in the fundamental sciences. The Advisory Council goes on to say: "And here a word of explanation is needed in view of ill-informed criticism of our policy. No conditions are attached to the grants made to workers whose sole aim is the extension of knowledge, either as to the line of their work or as to the use to be made of the results. If they propose to make commercial use of their discoveries we require them to consult us, because at this point they are leaving the field of pure investigation. But, subject to this single condition, their tenure is as free as, and in some respects more free than, that of a scholarship, fellowship, or professorship."

With respect to the organisation of industries into research associations, the present position is that eighteen research associations have been established, and that five others have been approved by the Department and will shortly receive their licences from the Board of Trade. Of the 1,000,000*l*. fund it is estimated that the Department is committed at the present time to a total expenditure of nearly 450,000*l*. on account of the established research associations, and to a further expenditure of at least 120,000*l*. on account of those approved but not yet licensed. The total commitments out of the 1,000,000*l*. fund are expected shortly to reach 800,000*l*., and the report observes: "It is clear that the sum placed at our disposal is not likely to be more than sufficient to aid the associations either formed or likely to be formed." There is much sanity in the reply of the Advisory Council to the criticism, actual or hypothetical, that much greater scientific results of value to industry would have been produced if the 1,000,000*l*. had been spent directly upon research done at the National Physical Laboratory and other research laboratories up and down the country. "Had the million been spent on research directed by the Government itself, its effect upon manufacturers would at the best have been destructive of their self-reliance, and at the worst a free gift to their competitors in other lands." We agree. Critics of this side of the Department's activities do not seem to recognise that to throw responsibility for research on the industries themselves is the surest way to educate the industries to appreciate the difficulty and the value of research.

A word may well be said here as to the statement in the report that at the end of the five years' period the research associations "must be prepared to continue without subvention from the State." The general principle is undoubtedly sound, and in the case of industries with large aggregations of capital there need be little fear that, having set their hands to the plough, they will turn back when the support of the State fails. For them the five years is probably a sufficient period. But there are industries, relatively small when measured either by the capital available or even by their production, which are, nevertheless, of vital importance to the State—"key" industries from their character rather than from their size. For these it may be necessary that State aid should be prolonged for more than the five years' period if, for them, the benefits of this research movement are to be consolidated and extended.

On the question of the conduct and co-ordination of national research the report truly observes that if the scheme for co-operative research in the several industries is to be a permanent success, provision must also be made for dealing with certain fundamental problems which are of such wide application that no single industry, however intelligent or highly organised, could hope to grapple with them effectively. The first of these basic problems is fuel. The Fuel Research Board was appointed in 1917 under the directorship of Sir George Beilby. A brief account of the activities of this Board is given. It includes such questions as "Gas Standards and the Development of the Gas Industry," "Peat as a Source of Fuel," "Pulverised Fuel," and problems of the production and utilisation of alcohol for power and traction purposes. Other instances of these "national researches" briefly reviewed in the report are the conservation of coal and mineral resources, the preservation of food, and the research into building materials and construction.

In the section dealing with the aiding of suitable researches undertaken by scientific and professional societies and organisations it is stated that grants have been made for the work on hard porcelain at the Stoke-on-Trent Central School of Science and Technology, that on glass technology at Sheffield University, and that on technical optics at the Imperial College of Science and Technology.

In concluding its short summary of the first five years' work the Advisory Council well says: "A longer period for review is specially necessary in our case, for research cannot be expected to produce results at short and regular intervals. Indeed, the expectation that it will is a misconception which has stood largely in the way of its consistent use by manufacturers, and has strained the patience of a public apt to think that the placing of an Act upon the Statute Book and the creation of a new organisation are all that is necessary to reach a desired end. If art is long in comparison with life, science, in spite of all its brilliant achievements, is longer still." That truth needs to be ever in the minds of those who deal with research.

The University of Birmingham.

ON Friday last, October 8, a number of influential representatives of Birmingham and the Midlands were the guests of the University of Birmingham at a luncheon in the Great Hall of the University at Edgbaston. The Chancellor (Lord Robert Cecil) presided, and the object of the gathering was to make known the need for increased financial assistance for the University.

Funds are urgently needed "to extinguish the debt of the University (130,000*l*.); to pay the staff of the University a living wage; to provide the necessary new accommodation and staff for the existing departments of science, arts, medicine, commerce, and education; to provide in all faculties facilities for research urgently needed in the public interest; to meet the greatly increased cost of administration and upkeep; and to enable the University to maintain its position among modern universities."

The Chancellor in calling upon Mr. Austen Chamberlain to speak welcomed him as one of the Members of Parliament for Birmingham, as Chancellor of the Exchequer, and more than all as the son of his father. Mr. Chamberlain, speaking first as a citizen of Birmingham, outlined the history of the civic expansion of the city in the days of his father, when the strenuous efforts of the leading men succeeded in making Birmingham a worthy metropolis of the Midlands, their work culminating in the foundation of the University. Speaking for the Government, he gave expression to the surprise with which they had learned the extent to which the country had been dependent upon university learning for success in the Great War. Now he "would say to an audience drawn from a great business community centring in Birmingham that if such services can be rendered by university learning in war-time, is it not certain that those services are equally necessary to our prosperity as a nation, and the prosperity of this city and district, amidst the difficulties and developments which have followed on the restoration of peace? Upon the recognition as a great community of the national and civic importance of such an institution as the University depends the ability to hold our place among the cities of the kingdom and the Empire."

The Government was fully aware of the immense importance of universities, and ready to back its opinion of that importance. It had spent for many years immense sums on elementary education; it had spent considerable sums on secondary education; but all too little on university education. Mr. Chamberlain had undertaken, unless he was prevented by overwhelming financial reasons, to submit to Parliament for next year a grant of 1,500,000*l*., and he had undertaken to consider—and though he could not promise, he hoped he might be able to do something in that direction—a further special non-recurrent grant in order to adapt the federated universities' scheme of pensions to the case of the older men who had joined and served the universities long before that scheme was in existence, and therefore on retirement would, without extraneous aid, receive only the smallest pittance from it. He hoped the grant would be on that basis for a term of years. What the University of Birmingham would get out of this depended on Sir William M'Cormick's Committee, which would advise the Government. He attached great importance to the advice of that Committee on the administration of the grant. "The less Government interference the better. Whatever you do, don't sacrifice your independence; don't come to that condition, one of those which brought Germany to her ruin." Professors of universities must be independent men, free to express their individual thoughts, subject to such control as the Chancellor or the authorities of the University might think right to impose on them. He did not want direct Government control or interference; he did not want party "pull"; he did not want anything to govern the grant except the relative merits of the recipients. Therefore he attached great importance to the independent Committee of Sir William M'Cormick, which had secured the confidence of every University which it was called upon to examine, and had been a real friend and of real assistance to those universities.

The Government had laid down general lines for the guidance of that Committee. In the first place, it could not encourage any university to undertake new developments before it had made adequate provision for that which already existed. If any grants are expected in respect of new developments, it must approve these new developments as being suitable to the general scope of the university in which they are proposed. Moreover, the work done must be of university standard. Finally, the grant would depend on the amount of local support given by the city and the Midlands. "If the citizens of Birmingham, if the towns and counties round, do not care enough for their University, and all that it means to them, to give it adequate local support, then whatever the Member for West Birmingham might be allowed to say, the Chancellor of the Exchequer will tell you flatly that if you do not value your Midland University you cannot expect the taxpayer at large to pay for conveniences for you to which you yourselves will not contribute." He most earnestly hoped that the citizens of Birmingham, and the counties and boroughs which surrounded them, would co-operate to make the University a common source of learning and of wealth for them all.

The Principal (Mr. C. Grant Robertson) read a letter from the President of the Board of Education, who wished success to the appeal, and remarked that "all over the country we are faced with the paradox that while the nation has never derived more benefit from its universities, these institutions have never found it more difficult to carry on their existence."

Mr. Grant Robertson pointed out that 42 per cent. of the students of the University came from Birmingham itself, 42 per cent. from the region round about, and the remainder from distant parts, and he hoped that the surrounding districts would contribute accordingly; at present their contribution was not one-tenth of that given by the City of Birmingham. He emphasised the underpayment of the staff; he believed that there was not one of them who could not double his income by leaving the University at that moment. By what moral right did we expect gifted men to give services at a wage which in industry would be regarded as contemptible? Professors could no more be improvised than admirals or generals. Facilities for research were indispensable; a university in which research did not flourish was a crippled institution. There was, too, a growing and insistent demand for extra-mural work that ordinary men and women might benefit. This demand must be met, but it could not be met without money. It was a most promising sign that the people were turning to the university to learn the duties and solve the problems of citizenship. They were asking for instruction in subjects which went to the root of civic life—history, political theory, economics, and civics—and by giving this instruction the universities would be doing much to make democracy safe for the world.

The problems of the present and near future were commonly called economic; they were really spiritual and moral, and they could not be solved by merely material remedies. We were victors in the war, and our universities might be made potent instruments in the spiritual, moral, and intellectual reconstruction of society. This might be an inauspicious time for an appeal, but the University was faced with a crisis; it must either act or succumb.

In the evening the Lord Mayor (Alderman William Cadbury) presided over a meeting in the Town Hall. Lord Robert Cecil made an eloquent appeal, showing the discreditable state of this country in the matter of university education as compared with the United States, with Germany, and, most of all, with Scotland. It was a curious fact that in England people seemed to think that anyone could use his mind without special training. This was a grave fallacy, and a university was essential to provide the necessary mental training which was so vital to us as a nation. With the increasing responsibility which was being thrust upon the people (in foreign politics, for example), it was of the utmost importance that the working classes should have full opportunities of receiving education, and especially university education.

Mr Neville Chamberlain, M.P., appealed especially to the manufacturers, banks, insurance companies, and others dependent on industry for their money. He contrasted the business methods of forty years ago with those of the present, showing that to-day—when even directors are supposed to know something of the business they direct—a constant supply of highly trained young men such as the University of Birmingham can provide is an essential factor in the success of our national commerce. If it paid men to invest large sums of money in securing the raw materials of their business, it must pay them even more to invest a modest sum in maintaining the efficiency of an institution which turns out brains—quite as important as raw materials in the success of a business.

A resolution—"That this meeting, recognising the importance of the University of Birmingham in the commercial, intellectual, and social life of the Midlands, and convinced of its need for greatly enlarged funds, cordially supports the appeal now to be issued"—was carried unanimously.

At the close of the meeting the Pro-Vice-Chancellor (Alderman Clayton) announced that a sum of 200,000*l.* had been conditionally promised.

Aeronautics at the Science Museum, South Kensington.

THE collection of aeronautics in the Science Museum has been recently rearranged, and now occupies one of the galleries of the new Science Museum Buildings in Exhibition Road, South Kensington. Many important additions have been made to it, so that visitors can study the development of aeronautics from early times in the many objects of great historical interest, while the progress made in aviation during the last six years is represented by numerous exhibits which have been recently acquired.

The collection is arranged in six sections: Aeroplanes and aeroplane models, aeroplane construction, engines, instruments, experimental apparatus, and ballooning.

In the first of these an object of especial historical interest is the Henson flying machine model of 1842–45, which bears a striking resemblance to the modern monoplane, but was doomed to failure chiefly on account of the lack of a light engine of high power. Early pioneer work in gliding is illustrated by Lilienthal's glider, similar to the one on which the inventor met his death in 1896.

The development of the modern aeroplane can be followed in the series of scale models by which the machines of the Brothers Wright, Voison, Farman, Blériot, Santos-Dumont, and the German Taube are represented. Among the full-size machines are the only existing machine of Cody and the Vickers-Vimy Rolls-Royce aeroplane which crossed the Atlantic last year.

In the section devoted to aeroplane construction are examples of historical and modern propellers, and actual portions of early and modern aeroplanes in which the methods of construction may be compared. Portions of an early Wright biplane have been preserved, and the visitor can operate and study the control mechanism of this machine.

The collection of aeroplane engines ranges from the early steam engines of Henson and Maxim to the modern high-power petrol engine, and the collection of engines of types used during the war, including British, French, Italian, as well as German, models, is of great interest.

A wind-channel and a water-channel for experimental work may be seen in operation; the principal instruments used in aerial navigation and reconnaissance are also shown. Balloons and airships are not as yet fully represented, but to all sections additions are continually being made.

University and Educational Intelligence.

Cambridge.—An extension of the metallurgical department of the chemical laboratory, provided by the generosity of the Goldsmiths' Company, was opened on October 5 by the Prime Warden. It includes rooms for the study of high temperatures, general metallographic research, assaying of gold and silver and their ores, a balance-room, and general provision for students working at analytical and general metallurgy.

E. K. Rideal has been elected a fellow of Trinity Hall, and H. Glauert and A. D. Ritchie fellows of Trinity.

We learn from *Science* for September 17 that the University of Buffalo has received from O. E. Foster a gift of 400,000 dollars for the erection of a chemistry building. It has also received anonymous gifts of 250,000 dollars towards endowment and of a library building.

A course of ten public lectures on "Medieval Contributions to Modern Civilisation" will be delivered at King's College, London, during the present term on Wednesdays at 5.15. Philosophy will be dealt with on October 27 by Prof. H. Wildon Carr, and Science on November 3 by Dr. Charles Singer. Other subjects are Religion, Art, Literature, Education, Society, Economics, and Politics.

The *Pioneer Mail* for September 17 states that the Bill to establish and incorporate a Moslem university at Aligarh has been passed by the Imperial Legislative Council. The Viceroy congratulated the Mohammedan community on the new institution, and several Mohammedan members expressed their thanks to his Excellency for his interest in the provision of educational facilities for their community.

In a public address delivered during the course of the recent second annual conference of the Reading and District Teachers' Association, Mr. H. A. L. Fisher, President of the Board of Education, stated some facts relative to the cost of education. In the last two years the net total expenditure has risen from 19½ millions to 45¾ millions, *i.e.* the cost of education has been more than doubled. The largest part of this increase is represented by additions to the salaries of teachers, of whom there are now nearly 200,000 in the public service. The additions to salaries amount to 130 per cent. increase on pre-war salaries, while the cost of living during the same period has risen by 152 per cent.; this increases the cost per child by 119 per cent. Before the war, local education authorities bore 53 per cent. of the expenses incurred, and the Board of Education 47 per cent.; now the position is exactly reversed. Mr. Fisher is of opinion that developments under the Education Act of 1918 and the cost of putting into effect the recommendations of the two Burnham Committees which are now sitting will give rise to a steady increase in the cost of education.

The report of the University of Leeds for the year 1918–19 has been received. Full lists are given of the professorial and executive staff, before entering upon the report proper, which, it is worth noting, is the fifteenth which has been issued since the charter was acquired in 1904. It reviews the growth of the University from the autumn of 1918 to the spring of 1920, although the statistics and accounts are mostly confined to the session 1918–19. During the period under review the number of students taking full-time courses has been doubled; unfortunately, only one-sixth of this number enjoy collegiate life in the limited number of hostels available. The financial strain caused by the increased demand for higher education bears heavily on the University, and in consequence an appeal for 500,000*l*. has been issued. During the war more than fifteen hundred members served in his Majesty's forces, and some five hundred casualties were sustained. The head of the chemical department acted as chief chemical adviser to the Home Forces, and other members of the faculty undertook the responsible duties of testing varnishes, of manufacturing antiseptics and drugs, of testing high explosives, etc. The leather, engineering, textile industries, and colour chemistry departments also took active parts in researches instituted by the Government. Among the grants which have been made to the University, the most important is a sum of 36,000*l*. from the Treasury as an annual grant, and a further non-recurrent sum of 9000*l*. for the session 1920–21. An annual grant of 3800*l*. for five years has also been made towards the maintenance of the School of Agriculture. A number of friends of the late Sir Swire Smith from Keighley and district have raised the sum of 3000*l*. for the endowment of a fellowship, open to graduates of any faculty, for the purpose of conducting research. The remainder of the report is devoted to a statement of the deaths, resignations, and appointments of University officials. Towards the end of the report each department is taken separately, and an account of its work during the past academic year given.

Societies and Academies.

PARIS.

Academy of Sciences, September 20.—M. Léon Guignard in the chair.—H. **Lecomte**: The radial secretory canals of wood. The usual direction of these canals in the tissues of the stem and root is parallel to the length of the organ, but a system of radial secretory canals may, in a large number of plants, be superimposed on the longitudinal system. These radial canals have been noted by Trécul and others, but have hitherto been regarded as exceptional cases. In the genera Pinus, Picea, and Larix the radial canals are now found to be present in all cases, and numerous examples were also found in other species.—P. **Humbert**: Hypercylindrical functions in space of $n+2$ dimensions.—J. **Soula**: Remarks on the investigation of the singular points of a function defined by a development in Taylor's series.—J. **Andrade**: The geometrical interpretation of the Résal-Caspari method.—A. **Véronnet**: Values of the flattening of the earth obtained by calculation and by measurement.—A. **Buhl**: The formula of Stokes in space-time.—M. **Flajolet**: Perturbations of the magnetic declination at Lyons during the second half of 1919 and the first half of 1920. The observations are tabulated in six groups between calm days and perturbations greater than 30′. On August 11, 1919, and March 4, 1920, the disturbances were very large and outside the scale of the recorder.—H. **Coupin**: The resistance of seedlings to starvation. The seedlings of seventeen species of plants grown in the dark in distilled water lived from fifteen to sixty days.—F. **Vlès**: The production of difference spectra of toxin cultures. Further study of the changes produced in the absorption spectra of toxin cultures by heating and by the addition of antitoxin.—C. **Lebailly**: The prevention and treatment of aphthous fever by the serum or blood of cured animals. Experiments were made on more than five hundred animals. The immunity produced by the injection was of very short duration, in some cases less than fifteen days. Good results were obtained in the treatment of infected animals, provided that the injections were made as soon as possible after the disease was recognised.

CAPE TOWN.

Royal Society of South Africa, August 18.—Dr. A. Ogg, vice-president, in the chair.—P. A. **van der Bijl**: Note on *Lysurus Woodii* (MacOwan), Lloyd. The fungus described was found in a rhubarb trench in Natal. It is entirely distinct from the genus Anthurus.—C. **Pijper**: A prehistoric rock-sculpture from the North-Eastern Transvaal. Circular and semicircular stone markings are described, with photographs, from the Lijdenburg district, not far from stones engraved with cup-and-ring markings, which the author has previously described.—J. **Moir**: Colour and chemical constitution, part xii. The calculation of colour from the tautomeric theory. Assuming that the tautomerism C·C·OH⟶CH·C·O has the value λ 94, the tautomerism $C{\cdot}C{\cdot}NH_2{\longrightarrow}CH{\cdot}C{\cdot}NH$ the value λ 98, and the tautomerism $C{\cdot}C{\cdot}CH_2{\longrightarrow}CH{\cdot}C{\cdot}CH$ the value λ 103, it is shown that the molecule of a coloured substance can generally be dissected into tautomeric pieces, loaded with non-tautomeric portions which have very little effect on the colour (λ 7 to 20 only). On adding up the values of all the pieces the result agrees closely with the λ observed in the coloured substance. Yellow and orange substances have 3 or 4 tautomerisms, pink and purple substances 4 or 5, and blue and green substances 5 or 6.

SYDNEY.

Royal Society of New South Wales, August 4.—Mr. James Nangle, president, in the chair.—Dr. W. G. **Woolnough**: A geological reconnaissance of the Stirling Ranges of Western Australia. The Stirling Range is an isolated mountain block situated about sixty miles north of Albany. It is composed of interbedded quartzites and slates, devoid of fossils, and probably Proterozoic in age. While locally folded, faulted, and overthrust, the rocks are mostly horizontally stratified. The sedimentary formations are surrounded by a vast expanse of gneissic rocks, probably Archæozoic in age. After discussing the various possible explanations of the structural features observed, the author arrives at the conclusion that the sedimentary rocks were originally preserved in a long east-west fault trough, and suffered peneplanation with the rest of the "Darling Plateau" of Western Australia. Later, on the uplift of the peneplane, the old fault planes were rejuvenated, with the result that the original senkungsfeld was converted into a horst. A generalisation, which may be of far-reaching importance, is suggested, namely, that the granites of Australia lying west of a line joining Adelaide with Cloncurry are all Pre-Cambrian in age.—R. H. **Cambage** and H. **Selkirk**: Early drawings of an aboriginal ceremonial ground. The rough drawings were made by Surveyor-General Oxley in his field-book at Moreton Bay in 1824, and show the plan of a spot, as Oxley writes, "where the natives meet after a war with adverse tribes to make peace." This appears to be the first drawing showing the lay-out of a ceremonial ground of this nature in Australia, and has remained in obscurity for ninety-six years.

Books Received.

Commercial Arithmetic and Accounts. By H. H. Green and T. Franklin. With Answers. Pp. xi+337+xxxiv. (London: Macmillan and Co., Ltd.) 6*s*.

Matter and Motion. By the late Prof. J. Clerk Maxwell. Reprinted with Notes and Appendices by Sir Joseph Larmor. Pp. xv+163. (London: S.P.C.K.; New York: The Macmillan Co.) 5*s*. net.

The System of Animate Nature. The Gifford Lectures Delivered in the University of St. Andrews in the Years 1915 and 1916. By Prof. J. Arthur Thomson. Vol. i. Pp. xi+348. Vol. ii. Pp. v+349–687. (London: Williams and Norgate.) 30*s*. net.

The Natural History of South Africa. Mammals. By F. W. Fitzsimons. Vol. iii. Pp. xiii+278. Vol. iv. Pp. xix+271. (London: Longmans, Green and Co.) 12*s*. 6*d*. each vol.

Principles and Practice of Operative Dentistry. By Dr. J. S. Marshall. Fifth edition. Pp. xxix+711+xvi plates. (Philadelphia and London: J. B. Lippincott Co.) 35*s*. net.

Pure Mathematics for Engineers. By S. B. Gates. Part i. Pp. xi+191. Part ii. Pp. xi+179. (London: Hodder and Stoughton.) 4*s*. 6*d*. net each vol.

Reminiscences and Anticipations. By Prof. J. Joly. Pp. 264. (London: T. Fisher Unwin, Ltd.) 15*s*. net.

Memoirs of the Geological Survey, Scotland. The Economic Geology of the Central Coalfield of Scotland. Area iv., Paisley, Barrhead, Renfrew, and the Western Suburbs of Glasgow North and South of the Clyde. By L. W. Hinxman, E. M. Anderson, and R. G. Carruthers. Pp. iv+110+viii plates. (Edinburgh: H.M. Stationery Office; London: E. Stanford, Ltd.) 6*s*. net.

The Case against the Lloyd George Coalition. By H. Storey. Pp. v+103. (London: G. Allen and Unwin, Ltd.) 1s. net.

Historical Geography of Britain and the British Empire. (In two books.) By T. Franklin. Book ii., The Expansion and Consolidation of the British Empire, A.D. 1800 to Present Day. Pp. viii+152. (Edinburgh: W. and A. K. Johnston, Ltd.; London: Macmillan and Co., Ltd.) 2s. net.

Primitive Time-Reckoning. By Prof. M. P. Nilsson. Pp. xiii+384. (Lund: C. W. K. Gleerup; London: Oxford University Press.) 21s. net.

The Life of Ronald-Poulton. By his Father, Edward B. Poulton. Pp. xi+410. (London: Sidgwick and Jackson, Ltd.) 16s. net.

Phenomena of Materialisation. By Baron von Schrenck Notzing. Translated by Dr. E. E. Fournier d'Albe. Pp. xii+340. (London: Kegan Paul and Co., Ltd.) 35s. net.

Memoirs and Proceedings of the Manchester Literary and Philosophical Society. Vol. lxiii. (1918–19). (Manchester.) 12s.

The Cambridge Pocket Diary, 1920–21. Pp. xv+269. (Cambridge: At the University Press.) 3s. net.

The Elements of Plane Geometry. By Dr. C. Davison. Pp. viii+280. With Answers. (Cambridge: At the University Press.) 10s. net.

The Principles of the Phase Theory: Heterogeneous Equilibria between Salts and their Aqueous Solutions. By Dr. D. A. Clibbens. Pp. xx+383. (London: Macmillan and Co., Ltd.) 25s. net.

The Psychology of Childhood. By Dr. N. Norsworthy and Dr. M. T. Whitley. Pp. xix+375. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 10s. net.

Educational Psychology. By Dr. D. Starch. Pp. xi+473. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 14s. net.

Practical Chemistry: Fundamental Facts and Applications to Modern Life. By N. H. Black and Dr. J. B. Conant. Pp. xi+474. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 11s. net.

A Study in Realism. By Prof. J. Laird. Pp. xii+228. (Cambridge: At the University Press.) 14s. net.

An Outline of Physics. By L. Southerns. Pp. xv+202. (London: Methuen and Co., Ltd.) 6s. 6d.

Papers Set in the Mechanical Sciences Tripos, 1912, 1913, 1914, 1915, 1919. Pp. iv+57. (Cambridge: At the University Press.) 4s. net.

Diary of Societies.

THURSDAY, OCTOBER 14.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—H. A. Hughes and P. F. Everitt: The Field of View of a Galilean Telescope.—B. K. Johnson: The Calibration of the Divided Circle of a Large Spectrometer.

INSTITUTION OF AUTOMOBILE ENGINEERS (at 28 Victoria Street), at 8.—Graduates' Meeting. Messrs. Chatterton and Watson: Factors affecting Power Output.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Dr. E. S. Reynolds: (Presidential Address), The Causes of Nervous Disease.

FRIDAY, OCTOBER 15.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30—T. M. Ainscough: British Trade with India.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5—Prof. A. Keith: Demonstration on the Contents of the Museum.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—A. Keighley: An Evening in Lakeland.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—R. S. Fox: Elementary Physics and Chemistry in Relation to Motor Cars.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—S. Gilbert Scott: Presidential Address.

SOCIETY OF TROPICAL MEDICINE AND HYGIENE, at 8.30.

SATURDAY, OCTOBER 16.

PHYSIOLOGICAL SOCIETY (at Guy's Hospital), at 4.

MONDAY, OCTOBER 18.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 4.—Sir Frederick Andrewes: Harveian Oration.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. S. G. Shattock: Demonstration of Pathological Specimens in the Museum.

TUESDAY, OCTOBER 19.

ROYAL HORTICULTURAL SOCIETY, at 3.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—Sir Arthur McD. Duckham: Coal as a Future Source of Oil Fuel Supply.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. P. Chalmers Mitchell: Report on the Additions made to the Society's Menagerie during the months of June, July, August and September.—Dr. E. H. Hankin: Observations on the Flight of Flying-Fishes.—Dr. W. N. F. Woodland: Some Results of Ligaturing the Anterior Abdominal Vein in the Indian Toad (*Bufo stomaticus*).—G. Cotterell: Life-History of the Yellow Dung-Fly: a Blow-Fly Check.

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NATURE

THURSDAY, OCTOBER 21, 1920.

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Methods and Aims of Anthropology.

PROF. KARL PEARSON'S presidential address to the Anthropological Section of the British Association at the recent Cardiff meeting sounded a note of challenge which it is not usual to hear from the chair. Yet perhaps few of his audience were inclined to agree with him in this case that "a Daniel had no right to issue judgment from the high seat of the feast." In science, perhaps even more than in other departments of human affairs, criticism is the breath of life, and perfection, if it were attainable, might prove perilously akin to stagnation.

Although Prof. Pearson disclaimed any intention of speaking in a controversial spirit, his address was in fact a severe indictment of the traditional subject-matter and methods of anthropology. "Why is it," he asked, "that we are Section H and not Section A?" Anthropology should be the "Queen of the Sciences," the crowning study of the curriculum. If, in fact, it does not occupy this position, whose is the responsibility and what is the reason? His address was at once an answer to these questions and an attempt to suggest a remedy for what he feels to be the present unsatisfactory position of the science.

Anthropologists will cordially endorse Prof. Pearson's contention that the claims of anthropology as a leading science have not received full recognition, either from the State or the universities: they are unlikely, as a body, to agree with him as to the cause. For in his view the responsibility lies with the tradition of the orthodox school, in respect both of subject-matter and of method. Anthropology, and in particular anthropometry, he maintains, has produced no results of utility to the State, and its methods are not of such a kind as to afford either the training of the mind or the doorway to a career which would attract young men entering the universities. His chief criticism was directed against the subject-matter of anthropometry, the multitudinous observations on "height-setting," and the censuses of hair and eye colour, "things dead almost from the day of their record." But further, he went on to say, the bulk of the recorders were untrained, and the associated factors, without which the records were valueless, were usually omitted. The anthropologist, seizing the superficial and easy to observe, had let slip the more subtle and elusive qualities on which progress depends. It was the psycho-physical and the psycho-physiological characters, and not the superficial measurements of a man's body, which carry the greater weight in the struggle of nations. On this ground Prof. Pearson refused to admit the plea of the supporters of "science for its own sake," who argue that researches not immediately "utile" will be useful some day, as has happened in the case of the study of hyperspace. Anthropometric studies, he holds, must turn to more certain appreciations of bodily health and mental aptitude if they are to be useful to the State.

It is perhaps worth while to note that the two points to which Prof. Pearson directs attention are not entirely in the same category. One is a question of the subject-matter of the science, the other of method. In the case of the latter it is true that anthropometric records have sometimes been vitiated by lack of training in the observer; and it is equally true that associated factors have not always been recorded. But both these are remediable defects which will tend to disappear with increased facilities for training and increasing knowledge of essential relations in the facts to be observed. Neither, unless shown to be inherent in the subject-matter or unavoidable, can permanently affect the position of the science.

But Prof. Pearson went further. He was not prepared to allow that the material furnished by the present methods of anthropometrics was even indirectly of value as an indication of a close association between physical characters and soundness both of body and of mind. His grounds for this view were twofold. In the first place, he maintained, purity of race is merely a relative term; but even granting the hypothesis of pure races, it is known by mass observation that (as a result of interbreeding) elements belonging to one race are found in association in the same individual

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with those belonging to others. A tall but brachycephalic individual will combine Alpine mentality with blue eyes. Prof. Pearson also referred to the case of Charles Darwin, whom he took as a typical English individual, purely English in mentality, and showed that his ancestry contained elements from every race in Europe. Even if at any time there had been association of physical and mental characters, it would break down by intermingling, except in cases specially isolated by natural or social conditions, as, for instance, in the non-intermarrying caste groups of India.

Having demonstrated the failure of the orthodox school of anthropologists, Prof. Pearson put forward three propositions as a basis of reform. "Anthropologists must not cease," he said:

"(1) To insist that our recorded material shall be such that it is at present, or likely in the near future to be, utile to the State.

"(2) To insist that there shall be institutes of anthropology . . . devoted to the teaching of and research in anthropology, ethnology, and prehistory.

"(3) To insist that our technique shall not consist in the mere statement of opinion on the facts observed, but shall follow, if possible with greater insight, the methods which are coming into use in epidemiology and psychology."

Anthropologists will agree, it may be assumed, as to the desirability of the object set out in the second of these propositions; they may even be prepared to give to the third a qualified support. But to confine scientific research to aims immediately recognisable as utilitarian, as Prof. Pearson's first proposition would seem to suggest, is a limitation which very few scientific workers, anthropologists or others, would, and none should, accept. Nor in this case is it necessary. The study of ethnological problems on the lines at present pursued by physical anthropology does not necessarily exclude the study of what Prof. Pearson calls vigoriometry and psychometry—the science of man is wide enough to embrace them both. Is it not a little premature to condemn anthropometrics? The study is not of great age; it is still at the stage of gathering evidence, and as this accumulates the problems change in character; methods are being tested and varied, and data are re-examined continuously. Finally, anthropologists themselves are convinced that the problems they hope ultimately to solve are worth while.

On the other hand, anthropologists deplore the fact that the State does not make greater use of their results. The claims of the science as a basis of legislation, and as an essential preliminary in the training of those who have to administer the affairs of, at any rate, our subject races, have repeatedly been urged upon the Government. There is, however, justice in Prof. Pearson's criticism that the anthropologist too often has omitted to show that his problems have a very close relation to those of the statesman and reformer. On this ground alone Prof. Pearson deserves well of the science if, as a result of his strictures, he should succeed in inducing anthropologists to state from time to time the broad issues involved in their research. In support of his views, Prof. Pearson states that the Governments of Europe have had no highly trained anthropologists at their command, and, as a consequence, the Treaty of Versailles is ethnologically unsound. Is this in accordance with the facts? It was surely the case that when the terms of that treaty were under consideration each country interested in the settlement of international boundaries produced masses of facts based upon the researches of skilled ethnologists. Unfortunately, the facts were selected or distorted to suit the ends of the parties interested. Where impartial conclusions were available, as in the case of the Balkans, they had to be set aside on political grounds. The defects of the Treaty of Versailles are defects of the politician, and do not lie by default at the door of the man of science.

The extensive political propaganda based upon a distorted ethnology which followed the Armistice illustrates one aspect of a flagrant misuse of scientific data. Prof. Pearson refers with approval to the manifesto of the German anthropologists, in which is sketched a programme of study in ethnology and folk-psychology of savage and civilised peoples, by which they hope to aid their country to recover its lost position in the world. Science is made subservient to a purely political end. Prof. Pearson himself speaks of speeding up evolution as an outcome of anthropological studies, and of breeding out the troglodyte mentality in man. But by whom and on what grounds is the direction of the evolutionary process to be determined? The end of science is truth, and its function is the investigation of facts and their relations, and not the formulation of ideals. The past history of anthropology teaches us that it has not been to its advantage that it has meddled in politics or in humanitarianism. To say that this or that type is desirable, that this or that mentality should be cultivated, is not the work of the anthropologist, but of the social reformer.

The Durability of Maritime Structures.

Committee of the Institution of Civil Engineers. appointed to Investigate the Deterioration of Structures of Timber, Metal, and Concrete Exposed to the Action of Sea-water. First Report of the Committee. Edited by P. M. Crosthwaite and Gilbert R. Redgrave. Pp. 301 + xxxiii plates. (London: The Institution of Civil Engineers; H.M.S.O., 1920.) Price 30s. net.

THE deterioration of buildings from ordinary physical causes has always been one of the most important considerations before the engineer and the architect, and in preparing their designs they have been under the necessity of adopting precautions and protective measures of various kinds. But the destructive influences which have to be counteracted under ordinary atmospheric conditions become tenfold more active and pernicious in a marine environment. The acidity and salinity of sea-water; the fluctuations of tidal level; the alternations of wetness and dryness in rapid and rhythmic sequence; the impact of waves, producing vibration; the penetration of wind-driven spray and the insidious attacks of marine organisms—all these result in an intensification of the ordinary process of decay. Although the phenomena are well known and their effects only too patent, yet until recently definite and trustworthy evidence as to the rate and extent of deterioration was not readily obtainable. Conditions varied greatly with the locality. Counteracting agencies, some obscure in origin, necessitated modifications in general conclusions. Records were but indifferently kept. For these and other important reasons, the Institution of Civil Engineers felt it imperative, in a matter of such vital concern, to set to work to collect such data as were available, and to institute investigations and experiments on a scientific basis. It accordingly appointed a committee of thirteen engineers of high standing and reputation, who co-opted four additional members, and these gentlemen have just issued their first report. Some forty ports in various parts of the world were selected as the field of inquiry, and memoranda furnished by the respective local engineers, or abstracts therefrom, as to the condition of typical existing structures, are incorporated in the report.

The volume commences with an abstract from the Proceedings of the Institution of Civil Engineers of information contained in various papers relating to the subject. This has been prepared by Mr. G. R. Redgrave, who collates the data under the heads of timber, concrete, iron and steel. Mr. H. W. FitzSimons, in conjunction with Mr. F. T. Brooks, contributes a useful article on the value of timber as a material for marine structures, with botanical observations and notes. Next is a short monograph on marine boring animals, prepared by Dr. Calman, of the department of zoology, British Museum. This classifies the information at present available relative to the Teredo and its allies, their habits and distribution. Dr. Friend follows with a paper on the corrosion of iron and steel, and the remainder of the book is taken up with the special reports (fifty-two in all) from engineers in different localities. There are two summaries at the end of the volume; the first, prepared by Mr. M. F. G. Wilson, is a synopsis of the local reports in regard to special features, and the second is a general report embodying the findings of the committee on the investigations as a whole.

The volume is, undoubtedly, a most useful collection of data and results, collected at considerable trouble, and for the first time collated in order and degree. At the same time, the diversity of testimony is so evident, and the lacunæ are so considerable, that the preliminary impression created is one of greater perplexity than before. Even Mr. Wilson has found it difficult in several cases to reconcile conflicting statements, nor can the local engineers always explain certain inconsistencies in the records of their experience. This is, perhaps, most particularly noticeable in regard to the depredations of marine organisms. Thus, of the activity of Limnoria on creosoted pitchpine, it is recorded that of two 14-in. square piles, located only 40 ft. apart in Holyhead Harbour, within a period of nine years one was reduced to 9 in. in diameter, while the other showed no sign of attack. In the estuary of the Mersey, adjacent to the open sea, the Teredo has been found only "in a few cases," and causes no trouble; at Bombay its ravages have been so devastating as to lead to the abandonment of timber for permanent sea works. Thus at the present stage it is only possible to form conclusions of a somewhat broad and tentative character, which will be the subject of closer investigation and later review.

The idiosyncrasies of timber-destroying organisms are particularly stimulative of inquiry, and not the least interesting feature of the report is Dr. Calman's study of their anatomical structure, development, and method of attack. The organisms include the ship-worm (Teredo), the gribble (Limnoria), Sphæroma, and Chelura. The first is a mollusc, the others are crustaceans. The family Teredinidæ is a comprehensive one, and includes not only the typical genus Teredo, but also the allied genera, Xylotrya and Nausitora. Species of the same genus, moreover, differ widely in habits, in habitat, and in geographical distribution. The "Teredo," as so designated by the engineer, may comprise at least some twenty or thirty different species. Some thrive in brackish water; others do not; *Teredo navalis* is intolerant of it. *Nausitora Dunlopei*, a tropical species, commonly lives in perfectly fresh water. Generally, it has been found that timber piles in muddy, or sewage-contaminated, water are least subject to attack, from which it seems evident that shipworms require clear and fairly pure water for their effective development. Notwithstanding the advantage derived in certain cases by the treatment of timber with creosote, it is noteworthy that no completely protective antidote has been discovered. Greenheart is the timber which offers most effective resistance to attack.

The corrodibility of iron and steel is a branch of the subject admitting of but slow determination, so-called "acceleration tests," having proved untrustworthy. The percentage of impurities and the precise composition of alloys are of fundamental importance. The first effect of chromium is that of increasing corrosion, but a further addition effects a retardation. Sir Robert Hadfield has informed the committee that he is experimenting with an alloy of iron and chromium which manifests considerable resistance to sea-water corrosion. The committee details certain arrangements which they have made with Sir R. Hadfield and Dr. Friend for testing the rate of corrosion of medium carbon steel, mild steel, "Galahad" non-corrosive steel, nickel steel, Swedish charcoal, iron, and cast iron. The duration of the experiments may extend to twenty years.

The most important findings of the committee include the following: Creosoting as a protective treatment for Baltic timber is justified at the home ports, but not in tropical waters; reinforced concrete is a more suitable material for adoption where the sea-worm is very active; and ordinary concrete, whether in block form or in mass, produces thoroughly permanent work, if carried out in the properly specified manner.

BRYSSON CUNNINGHAM.

Tropical Disease and Administration.

War against Tropical Disease: Being Seven Sanitary Sermons addressed to all interested in Tropical Hygiene and Administration. By Dr. Andrew Balfour. Pp. 219. (London: Baillière, Tindall, and Cox, 1920.) Price *12s. 6d.* net.

AN essential in medical treatment is that the patient shall have faith in the professed healer; his rulings must be accepted as well as his drugs. Hence, in a period when empirical observations were the necessary substitute for scientific investigation, occasionally it might not have been conducive to the bodily safety of the physician were the patient to doubt the soundness of the deductions therefrom. Argument was therefore successfully evaded by an assumption of mystery too deep for ordinary mortals to fathom; drug roots were gathered with incantations by moonlight—the fever-stricken patient submitted to being deprived of a breath of fresh air. With the physician of the present day, so far as drugs are concerned, the awe inspired by mysticism to some extent remains; professional ethics—to the advantage of the patient—ordain secrecy, but the crude rulings of the past have been superseded by the dicta of the science of hygiene, which insist that "prevention is better than cure." Its devotees demand, not professional mysticism, but world-wide propaganda. Nowhere, in the interests of life, is this more necessary than in those portions of the world vaguely termed the "tropics," where even useful, though ancient, empirical sanitary deductions have been forgotten, or have become inapplicable in the press of life accompanying modern civilisation.

It is a matter of common experience that whilst the average educated layman is capable of discussing the *rôle* of certain mosquitoes, flies, fleas, lice, and ticks in the spread of disease, he fails to understand that, not only philanthropy, but also the prosperity of commerce, facilities for intercommunication with areas supplying raw material and the availability of suitable labour therefor, very largely depend upon the prevention of preventable diseases in the tropics. Hence, if it were possible to convey to the busy layman where action is requisite and what measures are applicable, undoubtedly a great impetus would be given to applied hygiene. To this end that well-known authority upon sanitation in the tropics, Dr. Andrew Balfour, director of the Wellcome Bureau of Scientific Research, London, has written the work under notice.

The larger part of this work is occupied by a record of travels in Africa, Mesopotamia, the West Indies, and South America. *Inter alia*, much interesting information is given as to makeshift sanitary methods employed during the late war. The final chapters deal with the necessities and measures requisite for the central administration of public health, as exemplified by a suggested Ministry of Health for Egypt on lines proposed by a Commission appointed for that purpose.

Throughout the lightly written and interesting pages of this book Dr. Balfour has steadily maintained the underlying object of his travels, namely, taking his reader from area to area of the tropics, demonstrating existing sanitary defects and the possibilities of improvements were the existing fruits of medical research applied, and showing where further light on disease ætiology is requisite. He has thus met a long-felt want by placing at the disposal of both the medical and the lay reader valuable information hitherto unobtainable without toiling through masses of scientific publications or dry official reports. No politician need reflect that the matter thus condensed does not concern the prosperity of the Empire; no administrator dealing with tropical races will fail to perceive that there is here much matter that will aid decision when the multitude of counsellors confuse with diverse schemes to the same end, and demand finance instead of conferring wisdom; nor need the man of commerce hesitate in arriving at the conclusion that there is an indissoluble connection between production and the health state of labour. To the intending tourist the word pictures of scenery and the description of the characteristics of races must be a source of much interest. Indeed, even the humorist will find that there is scarcely a page which does not yield a specimen of that genial "pin-prick" banter with which the Scot is wont to drive home truths he conceives his audience has failed sufficiently to evaluate. W. G. K.

Yearbooks of Universities.

(1) *Athena: A Yearbook of the Learned World. The English-speaking Races.* Edited by C. A. Ealand. Pp. viii + 392. (London: A. and C. Black, Ltd., 1920.) Price 15*s*. net.

(2) *The Yearbook of the Universities of the Empire,* 1918–1920. Edited by W. H. Dawson. (Published for the Universities Bureau of the British Empire.) Pp. xiv + 503. (London: G. Bell and Sons, Ltd., 1920.) Price 15*s*. net.

(1) SIMULTANEOUSLY with the publication of the first volume of "Athena," "Minerva: Jahrbuch der gelehrten Welt" has made its reappearance after the war. It is described as the twenty-fourth yearly issue, 1920, the previous edition being for the year 1913–14. "Athena" is a stately volume (8½ in. by 5½ in.) of 392 pages. "Minerva," of just half the cubic capacity, contains 1148 (*plus* 118) pages. "Athena's" learned world is restricted to the English-speaking races. "Minerva" takes cognisance of all civilised peoples; although, as was inevitable, the editor has but little information to give regarding the universities and other institutions of higher learning of the countries with which, until recently, Germany was at war. Italy is an exception. The *personnel* and other particulars of the Italian universities and learned societies are given as fully as in pre-war editions. Of the great majority of British and American institutions the permanent features alone are set forth in a few lines. The editor is careful to state that figures, *e.g.* the number of books in a library, relate to the year 1914. In the rare instances in which a calendar of a British or a catalogue of an American university has been obtained, the names and offices of the members of the staff are set forth; but a study of the list will, usually, reveal its date.

Nevertheless, in accuracy, the advantage does not in all things lie with the English book. Turning first to the account in "Athena" of our two most famous universities, we read that Cambridge numbers 2700 students, Oxford 4582. The Vice-Chancellor of Cambridge is still Sir Arthur Shipley, although his successor, elected on June 1, 1919, entered upon office the following October. None of the names of the proctors and pro-proctors of Oxford tally with the University Calendar, 1920. Looking up the obituary notices of university professors which have appeared in NATURE during the past twelve months, we miss but one name from the lists given in "Athena" as those of members of existing university staffs. Some names of men who died still earlier are retained. It is not remarkable that "Minerva's" keen-sighted eyes have failed to discover the existence of the universities of Benares (1916) and Patna (1917); but such an oversight is less excusable in Ἀθήνη, who is not γλαυκῶπις only, but also νικηφόρος. The information given regarding the constitution and functions of the universities is very scanty. Under the names of the various British universities at home and overseas, we are told the number of terms in the year (without dates), the number of students (frequently omitted), in some cases the budget, and in all the degrees conferred and the colours of the hoods appropriate to each degree.

The statement that in the University of Durham the D.D. hood is of "scarlet cassimere, lined with palatinate purple silk," is, no doubt, of general interest, but the half-page devoted to the hoods of this university might possibly have been more profitably used. Even in this connection there are some curious irregularities. The hoods of the University of Wales (Cardiff) are carefully described as to form, material, and colours; but we find the list repeated under the heading "University College of North Wales, Bangor," which is not a degree-giving institution. The "University

College of Wales, Sea Front, Aberystwyth," is not similarly distinguished. No development of the past three years has so greatly interested the universities of the United Kingdom as the institution of the Ph.D., yet there is, so far as we can find, no reference to this new degree. The budgets of some of the American universities are likely to make a Briton envious—Wisconsin, for example, has a revenue of 3,532,306 dollars; but it may well be for his peace of mind that Columbia, Harvard, Leland Stanford Junior, and others have modestly declined to disclose their wealth. The statement "No particulars received" follows the names of a large number of American and some British universities overseas.

(2) The aim of the "Yearbook of the Universities of the Empire" is different from that of the other two books. Each of the fifty-nine universities of the Empire finds it necessary to publish a calendar; the stouter, the more dignified. In the Yearbook all essential information regarding the origin of the university, its history and equipment, admission, faculties, degrees, scholarships, fees, hostels, etc., from each of these calendars, is reduced to a few pages. The names and offices of all members of the staff are recorded, and "since a statement of the sources of the various degrees held by university teachers gives, in small space, information regarding the educational history of their holders, much trouble has been taken in ascertaining their source." Under the heading "The Years 1916–19" events of interest in the life of the university, such as benefactions received, new posts created, alterations of curricula, etc., are recorded.

Comparing the present edition with the one which preceded it (1916–17), we note that the universities are no longer placed alphabetically throughout, but arranged in groups—England and Wales, Scotland, Ireland, Canada, Australasia, South Africa, India—with an admirable introduction preceding each group. A feature of the book which will make it of great and permanent interest is the Appendix on the Universities and the War. It is a summary of the services, other than combatant (these had been, in part, dealt with in the 1915 edition), rendered by the universities. "So numerous and varied have these been that it is impossible, in looking back, to picture the war as progressing towards a successful issue without them." This record, brief as it is, persuades the reader of the justice of the editor's remark. The compression within a book of this size of so much and such varied information reflects great credit not only upon the editor's diligence, but also upon his skill.

Encyclopædic Chemistry.

Phosphore, Arsenic, Antimoine. By Dr. A. Boutaric and A. Raynaud. (Encyclopédie Scientifique: Bibliothèque de Chimie.) Pp. iii+417. (Paris: Octave Doin, 1920.) Price 9.50 francs.

THIS book is one of the forty volumes on chemistry forming part of an encyclopædia of science which is expected to run to about a thousand volumes. The treatment aims at a compromise between text-books and dictionaries—the books being intended at the same time for reading and for reference. This is obviously a very ambitious scheme, and it raises the question as to whether such a compromise between matter and style is one which is likely to be useful. In the opinion of the reviewer, books intended for reference should aim at giving the fullest possible information in the smallest possible space. If the elementary rules of grammar are satisfied, the busy worker will be content, and questions of style have little interest for him. The references to original literature should in each case be checked carefully with the originals, and no differentiation should be made between the nationalities of the various discoverers. Although the well-known treatises compiled by German authors are not perfect, they are all we possess which have any pretension to completeness, and have proved of inestimable service to thousands of chemists of all nationalities. A proposal to publish such works in English has not proceeded beyond the stage of discussion, great as are the possibilities of success if trustworthy compendia could be issued within a reasonable period.

The book under review is written in a clear and readable style, and the descriptions and references are such as might be expected in a moderately advanced text-book. They are not nearly so complete as might reasonably be required in an encyclopædic work. The index is also far from satisfactory. The bulk of the references are to publications in the French language, and in more than one instance grave injustice is done in the text to workers of other nationalities. This is much to be regretted; science has no nationality, and in a search for information such questions have not the slightest interest for the reader. If this inclination is to be followed in further volumes to be issued, the reviewer has no hesitation in saying that the usefulness of the work will be profoundly prejudiced. It may, for instance, be more gratifying to the author to attribute the formulation of the equation for a unimolecular reaction to Berthelot, but as the prior publications of Harcourt and Esson and of Wilhelmi are readily accessible, and well known, at least to English chemists, the impression on the reader is far from satisfactory. Other instances of like nature could be quoted.

J. R. P.

Our Bookshelf.

The British Charophyta. By James Groves and Canon George Russell Bullock-Webster. Vol. i. Nitelleæ. With Introduction. Pp. xiv + 141 + xx plates. (London: The Ray Society, 1920.) Price 25*s*.

This monograph of the British Charophyta is a valuable addition to the literature of British botany. It has also a personal interest for many British botanists as representing the work on this group, embracing much of the leisure of forty years, of the brothers Henry and James Groves, to the former of whom the volume is fittingly dedicated. In 1880 Messrs. H. and J. Groves published in the *Journal of Botany* a "Review of the British Characeæ," in which an attempt was made to give an account of all the then-known British species, with illustrations and some particulars as to their variation and distribution. This was the first of a series of papers by the same authors, in which have been included descriptions and figures of fresh species added from time to time to the British list, records of distribution, and other notes. The present monograph, in which Canon Bullock-Webster co-operates, is the carefully considered outcome of these years of work. The systematic portion, which includes the first of the two subdivisions (Nitelleæ and Chareæ) of the group, is preceded by an introductory section dealing with the growth and structure of the Charophyta generally, and their distribution and affinities; this is well illustrated by numerous text-figures from various sources, and several plates. Each of the species is beautifully represented in a lithographed plate, mainly from drawings by Miss Mary Groves. The authors recognise six genera of Charophyta, five of which, Nitella and Tolypella, comprising the Nitelleæ, and Nitellopsis, Lamprothamnium, and Chara, included in the Chareæ, are represented in Britain. The key to all the British species, which precedes the general systematic account, includes thirty-two species, in several of which distinct varieties are recognised. Under each species there is a complete account of the synonymy with reference to previous publications, a full description in English, and an account of the distribution; notes on variation, affinities, and nomenclature are also added.

Monografia de l'Ordre dels Rafidiòpters (Ins.). By R. P. Longí Navas, S.J. (Publicacions de l'Institut de Ciències.) Pp. 93. (Barcelona: Institut d'Estudis Catalans, 1918.)

Father Navas is well known as a student of the taxonomy of that miscellaneous assemblage of insects formerly included in the old Linnean order of the Neuroptera. In the monograph before us he deals with the curious and remarkable "snake-flies." Their position in any scheme of classification has long been a difficulty, and opinions thereon are very diverse. Father Navas prefers to follow Handlirsch and to regard them as constituting an order of their own—the Raphidioptera. Others merge them along with the "alder-flies" (Sialidæ) to form the order Megaloptera, while a third alternative is that followed by some entomologists of combining the Megaloptera with the Plannipennia into a single order, Neuroptera. We are inclined to follow the intermediate course, as there is little doubt that the Raphidiidæ have their nearest allies in the Sialidæ, although they are more highly specialised than the latter.

The present monograph is exclusively systematic—only eight lines are devoted to the larval stages, for example—and the sole observations on structure deal entirely with those characters of the external anatomy which are utilised by the systematist. Two families are recognised, comprising thirteen genera and seventy-one species. The greater number of genera occur in Europe and North America; only one genus is African, and four are Asiatic, but none are peculiar to either of those continents. In Britain we have four species comprised within three genera, but the group has been hitherto so little collected that in the next decade we shall probably totally revise our views on its geographical distribution. The author has done a service in bringing together the various species within a single memoir, and his keys and descriptions will enable the different forms to be identified. Of the forty odd figures, many are sketchy and rather deficient in detail.

A. D. I.

Some Famous Problems of the Theory of Numbers and in particular Waring's Problem: An Inaugural Lecture delivered before the University of Oxford. By Prof. G. H. Hardy. Pp. 34. (Oxford: At the Clarendon Press, 1920.) Price 1*s*. 6*d*. net.

The theory of the integral numbers is a subject in which it is frequently easy to conjecture new results and extremely difficult to prove them. An example of a result which must have been based on conjecture is known as Waring's theorem, that every positive integer is the sum of nine (or fewer) positive cubes, of nineteen (or fewer) biquadrates, and so on. A proof of this result, asserted in 1782, was first approached by Prof. Hilbert, of Göttingen, who showed in 1909 that every integer n is the sum of a finite number not exceeding $g(k)$, independent of n, of exact kth powers. It has been established, by transcendental analysis developed long since the days of Waring, that $g(3)=9$ as asserted by him, but whether $g(4)=19$ is still uncertain, though this number has been shown not to exceed 37. The only positive integers known to be inexpressible as a sum of eight cubes (at most) are 23 and 239.

Prof. Hardy and Mr. Littlewood have recently developed a new method of applying properties of the Riemann zeta function to the type of problem to which Waring's theorem belongs. In his inaugural address to the University of Oxford on his appointment as Savilian professor of geometry, Prof. Hardy gives a most lucid account of the work on which he has been engaged along with Messrs. Littlewood and Ramanujan. The whole of it is expressed in non-technical language, and many gaps in the theory are explained. We specially note the first few pages as forming a model introduction to a professor's inaugural address. A statement on p. 15 needs amendment, integers expressible as a sum of two squares being of either of the two forms

$$M^2P \text{ or } 2M^2P,$$

where P is a product of positive primes $4k+1$.

W. E. H. B.

On Gravitation and Relativity: being the Halley Lecture delivered on June 12, 1920. By Prof. R. A. Sampson. Pp. 24. (Oxford: At the Clarendon Press, 1920.) Price 2*s*. net.

THERE is a special appropriateness, as Prof. Sampson points out, in choosing a gravitational subject for the Halley Lecture, in view of the important part that Halley played in securing the publication of the "Principia." The lecture is an able *résumé* of the various speculations on the subject, from Galileo's "Dialogues" and Newton's hypothesis of æther-pressure down to Einstein's theory. The author evinces the highest admiration for Einstein's skill in devising a formula which expresses his results "without redundancy, defect, or effort, and whose boldness, range, brilliance, and resounding successes" have commanded universal attention; but on proceeding to examine the formula in detail he confesses to his dislike of some of the devices employed, in particular imaginary time and the obliteration of the distinction between past and future. He alludes to Newton's experiment of the rotating bucket and to Foucault's pendulum experiment as establishing the possibility of detecting the absolute direction of an axis of rotation. It will probably be admitted, even by the convinced relativist, that it is of advantage to students to have the claims of the older "common-sense" kinematics placed before them in an attractive form, which the author has certainly done.

A. C. D. CROMMELIN.

A Primer of Air Navigation. By H. E. Wimperis. Pp. xiv+128. (London: Constable and Co., Ltd., 1920.) Price 8*s*. 6*d*. net.

THIS book provides an interesting and sound introduction to the subject of finding one's way in the air. In many ways the investigation of methods of air navigation is based on nautical experience, but the author points out that the reverse process is beginning to apply. The chief differences appear to arise from the greater speed of aircraft as compared with the steamship, and the considerable altitudes above sea-level reached by the aeroplane and airship. Height in itself gives a wider range of vision, and in clear weather allows a greater permissible error in dead-reckoning without loss of port than is required for a ship seeking harbour. These points are clearly brought out in the little book under notice, and the various steps involved, both of observation and calculation, are developed simply. Whilst non-mathematical in character, we suggest that "Air Navigation" would provide a suitable starting-point for the more complex studies of advanced works and, what is perhaps more important in the present state of aeronautics, encourage capable students to extend the subject into regions yet unexplored. The main ideas of navigation are illustrated by examples from the great flights of the post-war period—Atlantic and Australasian. The correction for wind for aircraft is more important than that for tide and steamship, and clouds interfere with surface observations to an undesirable extent. Such difficulties, at any rate near land, will be countered by the use of direction-finding wireless telegraphy, a subject dealt with in one of the chapters of the book, which may be recommended as covering the essentials of present-day knowledge.

A Junior Inorganic Chemistry. By R. H. Spear. Pp. viii+386. (London: J. and A. Churchill, 1920.) Price 10*s*. 6*d*. net.

ALTHOUGH this does not seem to possess any features differentiating it from many other elementary text-books on chemistry, it is clearly written, and obviously the work of an experienced teacher. In some cases the information is not up-to-date, as on p. 128, where it is stated that "experiments carried out with the most elaborate precautions have shown that 1 grm. of hydrogen combines with 7·98 grm. of oxygen." Ozone is said (p. 177) to have "a faint, peculiar smell." Although molecular formulæ and equations are used freely from p. 152, the molecular theory is not explained until p. 278 is reached. Instructions for experiments are given throughout the book, which provides a good introduction to chemistry.

Part i. of the book, containing the first thirteen chapters, which lead up to, but do not include, the atomic theory, is published separately at the price of 5*s*. net. It provides an introductory course for junior forms in schools.

Atomic and Molecular Theory. By D. L. Hammick. Pp. 82. (Winchester: P. and G. Wells, 1920.)

As an exposition of the simple applications of the atomic theory to chemistry, this account leaves little to be desired in clearness and accuracy. Nothing, however, is said of the recent work which has put the atomic theory on an entirely new basis, and the point of view is that of twenty years ago. One cannot now truthfully say that "Dalton's hypothesis merely restates the facts about the elements and their modes of combination in terms of atoms and, as an 'explanation,' is not very satisfying."

Organic Chemistry for Medical, Intermediate Science, and Pharmaceutical Students. By Dr. A. Killen Macbeth. Pp. xi+235. (London: Longmans, Green, and Co., 1920.) Price 6*s*. 6*d*. net.

As an introductory text-book for the classes of students indicated in the title, this should be very useful. It is clearly written, and provided with exercises. One might have wished for a little more experimental detail; beginners in organic chemistry are liable to get into the habit of "removing hydroxyl groups," or "adding halogen atoms to double-bonds," or similar hypothetical operations, when they are asked to describe some simple laboratory operation. Chap. xviii., on "Schematic Representation," should be found helpful by students, as the subject is not usually dealt with in text-books. Slight weakness in physico-chemical theory is sometimes detected—*e.g.* on p. 5, with reference to fractional distillation, one finds only the misleading statement that "the more volatile vapour passes on to the condenser, and a sharp separation is effected." The elementary facts of fractional distillation are not often explained in text-books on organic chemistry.

Lead: Including Lead Pigments and the Desilverisation of Lead. By Dr. J. A. Smythe. (Pitman's Common Commodities and Industries.) Pp. vii+120. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) Price 3*s*. net.

Dr. Smythe's interesting account of the mining, extraction, and uses of lead should be found useful by teachers and students of chemistry, as well as entertaining by the general reader. The illustrations, partly reproductions of old cuts from Agricola and partly of modern plant, add considerably to the interest and value of the book. A good description is given of the manufacture of white lead, and of the methods of separating silver from argentiferous lead.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of Nature. *No notice is taken of anonymous communications.]*

"Momiai."

In Gen. Alexander Cunningham's "Ladak," 1854, p. 237, we have probably the first mention of this substance among the mineral productions of that country. Gen. Cunningham says: "The common *momiai* of Indian medicine is, of course, a manufactured article; although not made, as generally asserted, of the melted fat of Abyssinian boys who have been roasted for the purpose. . . . The original *momiai* was only mummy, which at one time was held in much repute in Europe."

It is interesting to note that the extraction from young children still finds belief in India; further, that it is made again a strong lever in the hands of dangerous agitators to disturb and rouse the feelings of the people and set them against their rulers.

I am led to write on this because in the *Morning Post* of September 29 there is a communication from its Calcutta correspondent (dated September 3) which is worth reading just at present, when all is not going well in India, events taking place which recall the days before the Mutiny of 1857. "A crazy rumour and its effects" is the subject I especially notice, a part of which I must quote; it is so similar to what was in circulation in the Mutiny year:

"At Khargpur, the Swindon of one of the largest railways in India, the ignorant people, including some of the workmen in the railway workshops, had been for some time much excited over a ridiculous and false rumour which still obtains currency all over the country wherever large building works are in contemplation, to the effect that the Government wanted a number of children for sacrifice, without which the buildings of the new district headquarters could not stand. In this instance the people believed that several men had been authorised by the District Magistrate to wander throughout the district kidnapping children. The rumour obtained such wide currency that the District Magistrate went to Khargpur several times, and both the executive and the railway authorities did their best to remove the superstitious belief. The District Magistrate also issued notices in the vernaculars contradicting the rumour."

History is repeating itself. In April, 1857, I was on my way to join the Kashmir Survey Party at Rawul Pindi; there the first rumblings of the coming Mutiny were heard by me. Very few Europeans then had a notion that such a conflagration was soon to come. Warnings were not taken seriously, and were more often received with ridicule. There was unrest in many forms, not so widespread as it is now. To give an idea of the reports then in circulation, one of my servants, on returning from the city where he had gone to make purchases, came at once to ask me whether it was true that the Queen of England was sending out to India an army of several lakhs of men to force the population of India to be Christians. I told him it was nonsense, and asked where he had heard it. He said two Faqirs (religious mendicants) were preaching on the invasion in the streets of the city. The story had evidently made an impression on him, and it led to my having a conversation with another native, in which I heard for the first time of *momiai*, and was told that we sahibs made it. He gave me a very circumstantial account: that children were kidnapped, hung up by the heels, head downwards, and an incision made in the breast from which flowed the wonderful substance which gave us so much power. To prove his words, my informant, who was a Kashmiri resident in Rawul Pindi, said he could show me the very bungalow in which all this was done. It turned out to be the Masonic Lodge—"The Star in the East," I think it is called—situated in the cantonment of Rawul Pindi—the "Jadu Ghur," or mystery house, as it is always called by the natives. In my wanderings in the Kashmir Himalaya up to 1863 the story of the "Jadu Ghur" would crop up. It was thoroughly known in Kashmir, on into Ladak, and extended, I believe, into Central Asia, wherever Kashmir merchants are to be found.

I much fear my explanation of what is done in a masonic lodge, and of what its use is, did little to alter whatever was in the mind of my informant. I do know that these impossible tales carry enormous weight for evil among the mass of the people, both male and female. Their dissemination should be watched and met. "The Viceroy's suggestion that a dangerous agitation in India can be allowed to take its own course unguided and unimpeded by those in authority" is folly, and shows utter ignorance of the people he has been sent to rule.

H. H. Godwin-Austen.

Nore, Godalming, October 3.

Ewing's "Thermodynamics."

THE very appreciative review of my book on "Thermodynamics for Engineers," which appeared in NATURE of September 16 over the well-known initials "H. L. C.," points out what is certainly a mis-statement. Will you kindly allow me space to correct it?

On p. 123, in speaking of the Mollier chart, the co-ordinates of which are the total heat I and the entropy ϕ, I should have said that the critical point is "near," not "at," the point of inflection of the boundary curve. It is, as "H. L. C." suggests, a little above the point of inflection. The isothermal line which passes through the critical point suffers inflection in touching the boundary curve there. The line of constant pressure which passes through the critical point also has a singular point there, namely, a point at which

$$\left(\frac{d^2I}{d\phi^2}\right)_p = 0, \text{ and } \left(\frac{d^3I}{d\phi^3}\right)_p = 0.$$

Without undergoing inflection, it has a "stationary tangent" at the critical point. These features of the curves of constant temperature and of constant pressure which pass through the critical point are apparent in the $I\phi$ chart for carbonic acid, given on p. 148. It will also be apparent from that chart that the point at which both these singularities occur lies a little above the point of inflection of the boundary curve itself.

The following corrections should therefore be made on p. 123 of my book:

In line 1, for "at" read "near."

In the footnote, delete the last two sentences and substitute: "Hence also, at that point,

$$\left(\frac{d^2I}{d\phi^2}\right)_p = \left(\frac{dT}{d\phi}\right)_p = 0, \text{ and } \left(\frac{d^3I}{d\phi^3}\right)_p = \left(\frac{d^2T}{d\phi^2}\right)_p = 0,$$

since on the $T\phi$ chart the constant-pressure line through the critical point runs level and suffers inflection there. Thus on the $I\phi$ chart the constant-pressure line through the critical point has zero curvature there, though it does not suffer inflection."

Also, on p. 149, line 1, for "coincides with" read "is a little above." J. A. EWING.

The University, Edinburgh, October 13.

A Diver's Notes on Submarine Phenomena.

SIR RAY LANKESTER in one of his delightful popular papers describes how he found that the glowing light produced by rubbing quartz pebbles together could still be got when the rubbing was done under water, as, for example, when holding the pebbles submerged in a bucket. On the supposition that if the effect were connected with entangled or surface-adhering air it should be enhanced under a high pressure, an experiment was made. My occupation involves a good deal of diving work, and on a recent occasion I took down a few suitable pebbles to a depth of 21 fathoms. On rubbing them together sparks were produced to just about the same extent as when tried in a few inches of water. The light on the bottom was dim enough to allow of the sparks being seen, yet visibility was relatively good.

Wave-action at this depth can be very violent. The wreck of a freshly sunk Atlantic liner at the same place was battered to pieces in the course of a single gale, and the large stones strewing the bottom are flung about amongst her remains whenever there is a big, long swell running. As many of these stones are quartz, there may probably be considerable illumination on such occasions.

In connection with light under water, I may mention that if, as often happens, one's hand gets cut when working at a fair depth the blood streaming out into the water looks quite black, like ink, at the source, thinning out to a bluish cloud as it gets more diluted with sea-water. No trace of redness can be made out. Similarly, an abrasion looks like a dab of tar on one's hand. I presume that this effect is caused by the absence of red rays, which are cut off by the upper layers of water, and that it could be predicted; but I do not understand why in the same circumstances crabs (*C. pagurus*) look as red as they do on deck.

The volume of air in his dress at a given time is a matter of much importance to a diver. He has to control his buoyancy to suit the work in hand, and on a change of depth must rapidly adjust the valve to maintain the same volume during and after the change of pressure. Failure to do so results in a "squeeze" or a "blow-up," either of which may be fatal.

Fish with swim-bladders must have a similar practical interest in this application of Boyle's law, and a diver who considers the matter will be able to sympathise with them in the difficulties they must often encounter from their relatively slow means of adjusting volume.

Usually when a mine or similar explosion takes place under water numbers of swim-bladdered fish float to the surface. Stunned or injured, they have risen above the depth for which they were adjusted, and the resulting expansion of the bladder gases then overcomes any efforts they may make and surges them upwards, hopelessly out of control. In addition to the distension so often described, many of them, as I have found, are killed by rupture of the bladder and resulting internal hæmorrhage. It is curious that the escaped gas from the bladder often finds its way into the heart and great vessels, producing a condition like that due to compressed-air illness.

The diver going down to a wreck where blasting has been going on generally finds that numbers of fish have fallen to the bottom through a converse process and are lying there dead. On a recent occasion where blasting was going on almost daily the accumulation of dead pollack, pout, horse-mackerel, etc., on the bottom attracted swarms of spotted and spiny dogfish, which could always be seen cruising about among the wreckage, often with dead fish in their mouths. The blasting, of course, went on just the same, and heavy charges were often fired in the midst of these shoals, but I have never been able to find a dead dogfish on the bottom (having constant negative buoyancy, they always sink when dead). On the contrary, I have (from the ship) seen them rise to the surface immediately after an explosion in pursuit of the stunned swim-bladdered fishes and tear them to pieces as if nothing had happened. Dogfish have no swim-bladder, and its absence enables them, as in this case, to dash from a hydrostatic pressure of 57 lb. per sq. in. to atmospheric pressure and back again with their prey without ill-effects. Moreover, it is probably this absence of an included gas space which renders them so immune to submarine explosions.

Another point about swim-bladders. In the North Atlantic sunfish and basking sharks idling at the surface of deep water, with positive buoyancy yet without swim-bladders, are familiar and somewhat puzzling objects. With such means as one has aboard ship I find the specific gravity of skates to be 1063 and of spotted dogfish 1068; the latter sink quite fast when they stop swimming for a moment. Presumably a basking shark would have a similar specific gravity, yet it floats. To catch one and solve the problem is not easy, but a friend kindly harpooned a sunfish for me. It was 3 ft. long and weighed 115 lb. The body was completely enclosed in a rigid case of some tough tissue resembling cartilage to the naked eye, but extraordinarily light. This shell varied from 0·75 to 1·25 in. in thickness except about the head, where it was very massive. It could be dissected off in slabs, and the thicker of these floated when thrown overboard. With the absence of bone, an immense fatty liver, and this queer, buoyant cuirass, I think we have the solution in the case of the sunfish.

G. C. C. DAMANT.

H.M. Salvage Ship *Racer*, Portsmouth.

Old Irish Maps.

THE fact that I have been able to refer your reviewer to an important map with which he was previously unacquainted is some compensation for the necessity for his last sentence (NATURE, October 7, p. 180).

A few years ago I spent some weeks among the maps in the library of the Geological Society of London, and tried to settle the question of the dates and editions of Griffith's maps. Since your issue of October 7 I have re-examined the evidence, with the additional help of a volume of Dublin addresses, once the property of Prof. Phillips, which I have recently obtained. The only conclusion I have been able to arrive at is that the Irish and English literature on the subject is vague and contradictory.

The writer of Sir Richard Griffith's obituary in the *Geological Magazine*, 1878, p. 525, states: "So long ago as the year 1812 the first outlines were attempted of . . . a geological map of Ireland. No labour seemed to Griffith too great in order to carry out this great work satisfactorily. *Four editions* of it were published, the latest of which was issued in 1854." Judd (*loc. cit.*, 1898, p. 149) tells us the large map of Ireland was exhibited in 1838 and published in March, 1839, and a *second edition* was published in 1855.

On June 13, 1839, Griffith read a paper (Journ. Geol. Soc. Dublin, 1839, p. 78) on "Presenting to the Society the Geological Map of Ireland in the Large Scale, the Result of my Labours for Upwards of Thirty Years." Later (*loc. cit.*, 1857, p. 294) he read a similar paper on "Preparing the *Last* Edition of my Geological Map of Ireland dated April, 1855." Close (Journ. Royal Geol. Soc. Ireland, 1879, p. 141) stated: "Very shortly after that [April, 1838], in the same year, the large map . . . was brought out, though for some reason which does not appear it was not regularly published so as to be accessible to all until March 28, 1839, the date which is inscribed upon it"; and (p. 142): "In June, 1840, only fifteen months after the last-mentioned edition, a new issue appeared. . . . In the short time mentioned changes had been made in the map in no less than forty places." We also learn (pp. 144–45) that a small edition of the map was published, and in 1855 a revised and the last edition was issued.

Apjohn (*loc. cit.*, 1841, pp. 158–59) states that as early as February, 1841, "in point of fact, *three maps* have been published by Mr. Griffith, first, a map on a comparatively small scale . . . and subsequently a *first* and *second* edition of his large map. We have already seen how great are the discrepancies between the two larger maps"—this, be it noted, being *before* the publication of the 1853 and 1855 editions.

The Geological Society possesses a large map "revised in 1853," and a smaller map (*circa* 1860) by Griffith is "copied from the large map of 1853."

So among these conflicting contemporary statements as to dates and editions I may be pardoned, after this lapse of time, for requiring to be "corrected."

Museum, Hull. T. SHEPPARD.

A Visual Illusion.

MR. TURNER should have consulted some standard work on experimental psychology before claiming a visual illusion as "new" (NATURE, October 7, p. 180) and advancing an explanation which experiment has shown to be wholly inadequate to account for the retinal after-sensations of movement. The effects are quite independent of movements of the eyes, and as truly "sensory" in character as the after-effects of colour and brightness.

C. S. MYERS.

Gonville and Caius College, Cambridge,
October 17.

THE phenomenon referred to by Mr. Turner and by Prof. Boycott in NATURE of October 7 and 14, pp. 180 and 213, was described by Aristotle in his treatise on dreams ("Parva Naturalia") thus: "Also, the senses are affected in this way when we turn quickly from objects in motion, *e.g.* from looking at a river, and especially from looking at swiftly flowing streams. For objects at rest then seem to be in motion."

The phenomenon has since been rediscovered times out of number, *e.g.* by Purkinje in 1825, R. Adams in 1834, Johannes Müller in 1840, Sir David Brewster in 1845, etc. I reinvestigated it experimentally, and published the results of this research, together with a historical survey, as a monograph, "On the After-Effect of Seen Movement," in the *British Journal of Psychology* (Monograph Supplements, No. 1, Cambridge University Press).

A. WOHLGEMUTH.

70 West End Lane, London, N.W.6,
October 18.

THE visual illusion described by Mr. Turner and by Prof. Boycott in NATURE of October 7 and 14 was described by me in NATURE of October 18, 1917 (vol. c., p. 126), and commented on by Dr. F. J. Allen and others on pp. 146, 165, 225, and 325 of the same volume. It had also been described in NATURE, vol. lxx., p. 107, and vol. lxxviii., pp. 225, 277, and 305. It was also pointed out by me in vol. c., p. 284, that the phenomenon had been fully described by Dr. John Aitken in the *Journal of Anatomy and Physiology*, vol. xiii., p. 322. The illusion may, perhaps, be best seen by looking through a microscope and slowly rotating the stage; as soon as the rotation is stopped the field appears to be revolving in the opposite direction, and so strong is the illusion that the stage may again be rotated very slowly in the original direction for 10° or 15° and will appear to the eye to be perfectly still. The same phenomenon may be seen when a pianola roll is stopped, the roll appearing to be slowly moving backwards. In some forms of pianola there is, in front of the record, a glass panel on which is a small knob for opening and shutting the panel; if the finger is placed lightly on this knob while the roll appears to be running back, I have the very curious tactual illusion that the knob is also moving upwards, and that it presses more and more against the finger. One or two others, however, with whom I have tried the experiment do not perceive the tactual illusion.

C. J. P. CAVE.

Ditcham Park, Petersfield, October 17.

Possible New Sources of Power Alcohol.

By C. SIMMONDS.

TWO reports have recently been issued dealing with various aspects of the fuel question. The first[1] is devoted largely to a consideration of the supplies of alcohol which might be made available for use as a motor fuel; the second[2] includes a note upon the production of alcohol from coke-oven gas, with a memorandum describing the process now being developed experimentally for the purpose. In the present article it is proposed briefly to survey the position as regards alcohol, leaving aside the question of alternative motor fuels.

As noted in the first of the two reports, the enormous and rapidly increasing consumption of liquid fuels is tending to exceed production, so that it is very important to supplement those now employed by developing the use of new ones in every possible way. In the United Kingdom the quantity of petrol received during 1914 was about 120 million gallons; the imports in 1919 had risen to 200 million gallons, and the estimate for the present year is 250 million gallons.

It is now accepted that alcohol, either alone or mixed with other liquids, can be used to replace petrol in internal-combustion engines, the most suitable fuel being probably a mixture of alcohol with benzol, or with benzol and ether. But to get alcohol we must first obtain the raw materials. These are, in the main, starch- or sugar-containing plants. So far as this country is concerned, grain (barley), potatoes, and mangolds would appear to be some of the most suitable crops: the last has not hitherto been used for the purpose to any large extent. Reckoning, for present purposes, a gallon of alcohol of 95 per cent. strength as equivalent to a gallon of petrol, how much of these raw materials should we require to supply the 250 million gallons which represent our annual consumption of petrol?

We should want more than 4 million tons of barley, or 12½ million tons of potatoes, or 25 million tons of mangolds. Roughly, the total annual production of potatoes in the United Kingdom is only one-half, and of the other two materials barely one-third, of these quantities. The barley we produce is already largely used in the making of malt; the potatoes and mangolds are foodstuffs. Since this country is very far from being self-supporting in the matter of food, no considerable proportion of these crops could be diverted to increase the production of alcohol. They command a much higher price as foodstuffs than could be paid for them as sources of "power" alcohol.

Our own case is fairly typical of the position in general. Foodstuffs, whether produced at home or abroad, will probably for some time yet be too valuable for use on any large scale as sources of alcohol. Meanwhile, what of possible new sources?

As regards synthetic methods of making alcohol, there are only two which, so far, have come near to commercial success. One of these is the manufacture from calcium carbide, itself produced from coke and limestone. The carbide yields acetylene, which by appropriate chemical treatment is converted into acetaldehyde; and the aldehyde, when mixed with hydrogen and passed over heated nickel as catalyst, is reduced to alcohol. The process was to have been worked on a large scale in Switzerland, but little has been heard of it lately. It may have been remunerative during the war, but has not developed as much as was expected, and appears now to be hanging fire. In any case, cheap power for making the carbide is essential; and according to some German calculations it would be more profitable to convert the carbide into cyanamide, and use this as a fertiliser to increase the potato crop for conversion into alcohol. A much better yield would thus be obtained.

The other synthetic method is based upon the utilisation of a by-product. The gas emitted from coke-ovens consists mainly of hydrogen (50 per cent.) and methane (25 per cent.), with smaller quantities of nitrogen, water vapour, and tarry impurities, and about 2 per cent. of ethylene. After a preliminary purification of the crude gas to eliminate tarry matters, ammonia, naphthalene, and benzene hydrocarbons, the greater part of the ethylene can be absorbed in strong sulphuric acid, forming ethyl hydrogen sulphate, which, when diluted with water and distilled, yields alcohol. Experiments have shown the possibility of obtaining 1·6 gallons of alcohol per ton of coal carbonised, and according to some estimates the cost of manufacture would be about 2*s.* per gallon. Assuming a similar yield from all the coal carbonised in British coke-ovens (about 15 million tons per annum), the yearly supply of alcohol from this source would be about 24 million gallons. The manufacture, however, is at present only in the early stages, and it is too soon to judge what the permanent prospects are. But, even if the suggested yield of 24 million gallons is eventually reached—and this, for various reasons, is unlikely—it would be less than one-tenth of our present petrol consumption. It would be a very acceptable contribution, but insufficient. An increase of 100 million gallons or more should be aimed at.

Thus, for the moment at least, we are still dependent upon fermentation methods for any considerable increase in the supplies of alcohol. We come back, therefore, to the question of fermentable raw materials.

Still dealing with the needs and possibilities of

[1] "Fuel for Motor Transport." An Interim Report by the Fuel Research Board, Department of Scientific and Industrial Research. (1920.)
[2] "Fuel Economy." Third Report of the British Association Committee. (1920.)

the United Kingdom, it may be said that to produce an additional 100 million gallons of alcohol we should have either to devote about 847,000 more acres to potatoes at the present average yield of 5¼ tons per acre, or else to increase this yield to something above 9 tons on the present acreage. For the same quantity from mangolds an additional 513,000 acres would be required, or else a yield of 34½ tons per acre instead of the present average of about one-half this amount. Two suggestions have been made towards the possibility of effecting this increase. One is that by a greater use of fertilisers and better cultivation the crop yield might be raised sufficiently to meet the demand even with the present acreage, or with a relatively small increase. As regards potatoes, more than 10 tons per acre have been obtained in various Irish districts, so that an average of 9 tons does not seem impossible. The figures given by the Fuel Research Board for the mangold crop in 1919 work out to 16½ tons per acre, but some years ago the average was 20 tons, and 24–30 tons have been mentioned as obtainable. If the normal crop of mangolds under good conditions is anything like the last estimate, no very great increase in yield and acreage together would be required to give the raw material for 100 million gallons of alcohol.

The second suggestion is that, leaving apart the land at present cultivated for foodstuffs, waste land might be reclaimed and devoted to carbohydrate crops for alcohol production, so that there would be no diminution of present food supplies. Again turning to Ireland, there are, according to a recent writer, thousands, and even hundreds of thousands, of acres of waste land which could, without any great expenditure of money, be utilised for the purpose. In this country some small-scale experiments on reclamation are actually in progress at Holton Heath, where several acres of heath land have been reclaimed and planted with artichokes for a practical study of the question. At present, however, the work is not sufficiently advanced to allow of useful deductions being made.

The general conclusion arrived at in the interim report of the Fuel Research Board is that the production of alcohol in any considerable quantities from vegetable materials grown in the United Kingdom is not economically possible, owing to (1) insufficient acreage; (2) high cost of cultivation, harvesting, and manufacture; and (3) the fact that the most suitable raw materials are also important foodstuffs. The two suggestions noted above might go far to meet the first and third points, but the second still remains, and it is, of course, a crucial one. In tropical and sub-tropical countries, where land is plentiful, labour cheap, and sunshine abundant, it may be quite practicable to grow vegetable substances such as cassava, arrowroot, and maize at such a cost as will make them very important sources of alcohol. Maize has been much used in the past, but just now its price—no doubt an abnormal one—precludes its use on a large scale. In regions such as South Africa and South America, however, two or even three crops can be secured yearly, and it has been urged that with proper organisation and development this raw material could, under conditions of mass-production, become one of the most important supplies.

Turning now to other possibilities, one of the first to be mentioned is the utilisation of cellulose materials as sources of alcohol. Two processes are already well known; others are in the experimental stages only. The cellulose of sawdust and other wood waste can be hydrolysed with acids and partly converted into fermentable sugars. This process has been under trial for several years in America, but has not yet definitely established itself as a successful manufacturing operation in normal times. In countries where wood pulp is made, a considerable quantity of alcohol is obtained from waste sulphite liquor, a by-product which contains a small percentage of fermentable sugars produced during the treatment of the wood. An interesting recent proposal (Rogers and Bedford) is one for obtaining alcohol from rice straw and husk, a cheap raw material available in large quantities. The straw is softened by steaming, and treated with hydrochloric acid or with calcium hypochlorite and chlorine to disintegrate the fibres, then pulped, and the hydrolysis of the cellulose and starchy matters completed by means of diluted hydrochloric acid. After the conversion to sugar is finished, the acid is neutralised, and the solution of sugars fermented and distilled. It is understood that arrangements have been made for large-scale experimental trials of this process in India, with the view of ascertaining whether the production of fuel alcohol from these and similar cheap cellulose materials can be definitely established.

Experiments are also in progress to ascertain whether a micro-organism can be obtained which will effect the direct conversion of cellulose into fermentable sugar. Success on the lines of this or the preceding process would open out the prospect of utilising a large amount of waste cellulose substances as sources of alcohol.

Among other possible new sources may be mentioned a tuberous plant, *Polynnia edulis*, growing in the Andes, which is said to be now under trial in France. The tubers range up to 2 lb. in weight, and have a carbohydrate content comparing favourably with that of mangolds. A special sugar beet is also being experimented with. Little information, however, is available yet as to whether, in the matter of yield and cost, these plants offer any marked advantages over those now in use.

Our general survey indicates, therefore, that, although the home production may be appreciably increased, it is mainly to the organisation and development of our overseas resources that we must look for any very considerable increase in our supplies of alcohol cheap enough to be used as fuel.

The Natural History of Everyday Creatures.[1]

MISS FRANCES PITT has given us a delightful book of personal observations on the everyday creatures that may be met with in garden, meadow, and hedgerow—the mice, birds, frogs, toads, and other animals that every person comes across. She records what she has seen and learnt, and is plainly an observer of experience and insight. She shows the interest of the life at our doors, and makes it clear that there is a great deal still to be discovered. Her book is strongly to be recommended for young people, not only because of its interest and its simplicity of style, but also because of its scientific temper.

FIG. 1.—A toad climbing. From "Wild Creatures of Garden and Hedgerow."

We feel at every turn that here is an observer who has a great respect for facts. We recommend the book to young people—there is no writing down to them, but we are sure that many people who are not young in years will enjoy the author's observations thoroughly and learn much from them. The photographic illustrations are excellent.

The book begins with bats, which are bundles of peculiarities and puzzles. Let us take an example of Miss Pitt's method. When a bat, hawking in the twilight, makes a dash after an insect and catches it, it often apparently tumbles through the air for a foot or two. This is because the bat, having grabbed its insect, bends its head down into its interfemoral pouch, where its prey cannot escape, and crunches it quickly as the bat goes on flying. Now Miss Pitt won the confidence of a pipistrelle to such a degree that it sat on her hand and ate all the flies it could get—making nothing of twenty to thirty at a meal. "My little pipistrelle had hitherto caught and pouched all its food when on the wing, and from habit felt compelled to try and pouch the flies I gave it, though sitting in an attitude that made this almost impossible. The result was that time after time it tumbled over, and would right itself with such a puzzled and bewildered look! However, the difficulty of doing the proper thing did not stop it eating."

The bank-vole matches the soil, dead leaves, and withered grass so wonderfully well that it is very safe so long as it does not move; but if it moves too soon the kestrel drops on it like a stone. Miss Pitt kept three in a large glass-sided cage, and proved their fear of attack from above. "They did not take any notice of things moving beside them, but the slightest thing overhead sent them dashing for cover or made them crouch like stones where they were. The cage was arranged to be as much like part of a bank as possible." Of great interest is the story of a young thrush which took about a week to learn how to deal with snails. "It was very evident that he learnt by experience, and that the snail-cracking habit of the thrush is not a specialised instinct, but arises from the tendency of this bird to beat on the ground and thus kill any food, like a big worm, which cannot easily be managed. My thrush would beat and hammer anything that was at all troublesome or which he did not understand." This is the kind of observation that gives the book a high value. Dealing with shrews, Miss Pitt says: "It is only by watching these small animals that one can gain any idea of their untiring energy, intense vitality, and their great pugnaciousness. They are perhaps the most quarrelsome creatures in the world! If lions and tigers were as fierce, active, and fearless in proportion to their size, as shrews and moles are in comparison with their little bodies, what awful creatures they would be!" In regard to the death of large numbers of common shrews in the autumn, the author favours the theory that these animals are "annuals." Here, as in some other parts of the book, there is a useful exposure of the nonsense that is often talked about the misery and cruelty of wild Nature. "If to us it seems dreadful that death should be always on the watch

[1] "Wild Creatures of Garden and Hedgerow." By Frances Pitt. Pp. ix+285. (London: Constable and Co., Ltd., 1920.) Price 12s. net.

for them, it seems almost certain that the small animals enjoy their life to its utmost." We come next to a sympathetic study of frogs and toads. The toad's eyes are described as of "a pale metallic brown with reddish lights like flickering fires in their depths." This is good, but we do not like the suggestion that *iris* and *pupil* are synonymous, and we should not ourselves speak of the toad *ejecting* its poison. It is interesting to learn that toads will go over a mile to a particular breeding-pond—perhaps a sort of "homing." Miss Pitt's workmanship is first-class throughout, but she excels herself in dealing with mammals. What a fine picture she gives of the long-tailed field-mouse, with "great black eyes looking ready to jump out of its head," which washes itself when the least upset, a great climber, a burglar of bee-hives. If the tail is suddenly seized, it *skins*, and the animal escapes, very like "a special arrangement to enable its owner to get away from hawks and owls." The mouse does not bite off the skinned bone, as some books say; the caudal vertebræ dry up and fall off of their own accord.

We thought we knew something about moles, but we have learned much from Miss Pitt. For their size they are extraordinarily fierce and strong; they fight furiously, and it is doubtful whether a weasel could master one. On one occasion a mole moved a nine-pound brick, which is like a man moving more than three tons. Their rate of digestion is past belief, and they require meals almost continuously. One that was supplied with forty worms in the late afternoon was dead next morning—with an empty stomach. "Whatever you do, don't despise the 'poor little mole,' . . . in its dark tunnels it fights, hunts, feasts, mates, and enjoys life with quite as much gusto as the creatures of the light and air."

Miss Pitt made a fine experiment with a very young common rat, still blind, feeble, and very naked. She gave it in a diplomatic way to a cat, whose litter had been reduced to one—about ten days old. "I could hardly hope that the cat would be so good, or shall I say so foolish, as to nurse such an utterly different baby as the rat!" But that was what happened. The rat was accepted, cleaned, fed, fondled, tended, and treated just like the kitten along with which it was reared. Even after another family came to occupy the cat's attention, she remained on friendly terms with the rat and often paid him a visit. The cat in question had been a good ratter, but after the adoption ratting was done with!

In the study dealing with the pied-wagtails, willow-wrens, and great tits of a garden, the author notes that the parent wagtails worked for sixteen hours a day, and in that time brought food about 192 times to the nest; and it is not merely the going to and fro; there is the searching for insects in between. It is suggested, by the way, that the willow-wren's domed nest serves to keep the sun off the young birds, which are greatly distressed by heat. There is a lively account of the slow-worm, the common lizard, and the grass snake; thus in reference to the local life of the discarded tail of the slow-worm we read: "Fancy being able, when threatened by a foe, to throw off such an important part as a tail, and slip away, while it dances on the ground and occupies his attention." We have often found students puzzled by the expression "casting or shedding *the skin*"; and as Miss Pitt explains that the skinned tail of a field-mouse dies, perhaps she may be fairly asked to explain why a snake which sheds "many skins" is able to live on. It is new to us that the skeleton of the slow-worm shows rudiments of *legs*. We make such trivial observations because the book is so perfect.

FIG. 2.—The long-tailed field-mouse. From "Wild Creatures of Garden and Hedgerow."

A study of the short-tailed field-vole, prolific, harmful, greedy, but very likeable, raises a number of interesting points. The dull, dark brown fur is a good instance of prolonged sifting: "It is not that it matches either the stems of the grass, or the bare earth, but it goes wonderfully well with the shadowy places between the plants." Who can explain why a comfortably caged mother, captured along with her litter of six, will coolly and collectedly, after a careful toilet, remove one baby after another from the nest, and give each a sharp and fatal bite? The ways of mice and men! We have left to the end the story of the hedgehog, which Miss Pitt defends from many calumnies. Its appetite for a dead rabbit or the like has doubtless given some basis for misinterpretation. We doubt whether it is quite correct to say that the rolling-up musculature (*orbicularis panniculi*) of the hedgehog is also used in raising the spines, but perhaps Miss Pitt means merely that the contraction of the cap-like sheet is a factor in making the spines stand out firmly. We like what is said in regard to the individuality of hedgehogs and other beasts of the field. Miss Pitt is to be congratulated on a book which takes its place in the first rank of works on field natural history. It is a personal record of clever, patient, and sympathetic observation. J. A. T.

Obituary.

Prof. Yves Delage.

By a large number of zoologists, who have known the charm of Roscoff Marine Station during the last twenty years or more, the death of Prof. Yves Delage on October 8 will be felt as a personal loss. It was not merely that Prof. Delage grudged no time or trouble if he could help one with a piece of work; it was the impressive sincerity of the man and the simplicity with which he wore his learning. He had an encyclopædic knowledge of the shore-fauna and of the literature of biology, but he encouraged the learner with a Darwin-like humility. His devotion to science was singularly complete. All through his life, with an extraordinary intensity, he was preoccupied with biological and psycho-biological problems, and he did not often unbend his bow except for the simple pleasures of domesticity and the open air.

Yves Delage was born at Avignon in 1854 and educated at various provincial schools. He was greatly influenced in his student days by de Lacaze-Duthiers, whom he afterwards succeeded both at the Sorbonne and at Roscoff. It was under this master that he acquired a great liking for "microtomy" of a rather different sort from that which the word now suggests. We mean what Delage himself called "patient dissections under the microscope," the kind of investigation which he illustrated in his thesis (1881) on the vascular system of sessile-eyed Crustaceans. That he did not, however, stand so aloof as Lacaze-Duthiers did from the use of the microtome was shown in subsequent researches, such as those dealing with the development of sponges (1887). After a period of assistantship to Lacaze-Duthiers, of whom he always spoke with great reverence, Delage became professor at Caen and director of the adjacent Marine Station at Luc. He soon returned, however, to the Sorbonne, and was actively at work there until quite recently. He was elected a member of the Institute in 1901, about the time when he assumed full charge at Roscoff; he received the degree of LL.D. from Aberdeen University when he attended the quatercentenary celebrations in 1906; and he was awarded the Darwin medal by the Royal Society in 1916. For some years past his eyesight had given way badly, but his mental vision was unimpaired.

Delage's scientific industry was at once a reproach and an inspiration to those who knew him; it was almost incredible. His great book on "Heredity and the Great Problems of General Biology" (1895, second edition 1903) is a monument. It is marked by erudition, clearness of exposition, fair-mindedness, and keen criticism. We have temperamentally a great admiration for his judicial way of balancing evidence, sometimes so judicially that the reader's mind is left in a state of indecision. His own view was definitely neo-Lamarckian, and he had many a thrust at Weismannism. Then there are the twenty volumes or so of "L'Année Biologique," a very valuable series of critical summaries of current biological memoirs, even the last volume containing many contributions from Delage himself. Again, there are the half-dozen volumes of the "Traité de Zoologie Concrète," in which he was ably assisted by M. Hérouard and others. Besides these there were smaller undertakings, such as the very successful volume, written along with M. Goldsmith, on "Modern Theories of Evolution" (1909), and a similar volume on "Parthenogenesis" (1913).

Delage's most important contributions to zoology and biology have been (1) his fine study of the life-history of the extraordinary Crustacean parasite Sacculina, (2) his precise work on the development of sponges, and (3) his remarkable experiments on artificial parthenogenesis, with which his name (along with that of Jacques Loeb) will always be associated. We recall also the strange experiments on "merogony" and researches on the semicircular canals and otocysts. The study of the ear had a great fascination for him. Nor can we forget a long paper on a whale stranded near Luc, for it was in this connection, about 1885, that we had in our student days, working at the Luc laboratory, our first knowledge of Delage. We suppose that he made mistakes in his work like other distinguished men, but surely his life was marked by what he said Lacaze-Duthiers had by example taught to his school—"la persévérance, la suite dans le travail, la conscience dans l'observation, la sobriété dans les inductions théoriques."

Delage was at work at Roscoff this summer and autumn, and it is surely not unfitting that the last subject of his eager scientific analysis should have been *dreams*, on which we believe he had recently completed a treatise. A young student who returned last month from a working holiday at Roscoff has given us a pleasing glimpse, with which we close our appreciation. Every day after lunch it was Delage's habit to sit for a while in front of the laboratory so that any student might know he was then and there at home.

J. Arthur Thomson.

ASTRONOMY in Italy has suffered three heavy losses within a few months in the deaths of Riccò, Millosevich, and Celoria. GIOVANNI CELORIA, who died in Milan on August 18, was born in Piedmont in 1842, graduated at the University of Turin in 1863, and then studied astronomy at Bonn and Berlin. On returning to Italy he was appointed by Schiaparelli an assistant at the Brera Observatory, Milan, where he remained almost all his life, becoming director in 1900, on Schiaparelli's retirement, and himself retiring in 1917. Celoria's astronomical studies were devoted mainly to the structure of the star system; he repeated some of Sir W. Herschel's work on star-gauging, though with a much smaller telescope, and inferred the comparative thinness of the star-stratum in the direction of the north galactic pole from the fact that in this region he could see as many stars as Herschel had seen. He did useful work in another direction by collecting and discussing the records of several total solar eclipses the tracks of which crossed Europe in the Middle Ages, and he was able to fix the boundaries of totality with considerable precision; his work has been utilised by Dr. Cowell and others in the discussion of the secular acceleration of the moon. Celoria was also interested in geodesy, and held for a long time the chair of that subject in the Technical College of Milan. He was elected an associate of the Royal Astronomical Society in 1917.

WE regret to note that the death of MR. GEORGE TANGYE is announced in the *Engineer* for October 15. Mr. Tangye started business in Birmingham, with four other brothers, in 1858. The firm was a very modest undertaking at the start, but came rapidly into prominence on account of the successful launching of the *Great Eastern* steamship, which was accomplished by use of the Tangye hydraulic jack. The firm was one of the first to introduce steam-engines with interchangeable parts; its products in many fields of engineering have now a world-wide reputation. Mr. Tangye lived for many years at Heathfield Hall, formerly the home of James Watt. He carefully preserved Watt's garret workshop, and brought together a fine collection of relics of Boulton and Watt, which he finally gave to the city of Birmingham.

THE death is announced in *Engineering* for October 15 of SIR JOHN MCLAREN, who was well known in Leeds engineering circles. Sir John was born in 1850, and finished his education at Durham University. He started in business in 1876 with his brother, and his firm carried out many important contracts. When the war broke out he was made chairman of the board of management of the National Factories for Munitions in Leeds. He was a member of the Institution of Civil Engineers and of the Institution of Mechanical Engineers.

BY the death of MR. HENRY STEEL on October 7, chairman of the United Steel Companies, many organisations with which he was prominently connected have suffered a severe loss. Mr. Steel was educated in Brussels and at the University of London. The combine of which he was chairman included many large firms, and had a capital of more than 9,000,000*l*. He became a member of the Iron and Steel Institute in 1886.

Notes.

PROF. T. W. EDGEWORTH DAVID, C.M.G., F.R.S., professor of geology in the University of Sydney, has been appointed a Knight Commander of the Order of the British Empire (K.B.E.) for services in connection with the war.

THE gold medal of the Royal College of Physicians, which is awarded by the college every three years for distinction in public health, was presented to Dr. W. H. Hamer, Medical Officer of the County of London, on Monday, October 18.

THE Emil Fischer memorial lecture will be delivered by Dr. M. O. Forster at the ordinary scientific meeting of the Chemical Society on Thursday, October 28, at 8 p.m. By the courtesy of the Institution of Mechanical Engineers, the meeting will be held in the lecture theatre of that institution.

THE expedition sent by the Norwegian Government, in command of Capt. G. Hansen, to lay depôts for Capt. Roald Amundsen has returned safely, having accomplished its task. The *Times* announces that Capt. Hansen, after wintering in the Eskimo settlement at Thule, started northward in March this year, accompanied by several Eskimo who had previously served with Peary. The march was along the coast of Greenland by Smith Sound and Kane Basin. North of Franklin Island fast sea-ice several years old enabled the expedition to cross Kennedy Channel to Grinnell Land. With some difficulty, due to extremely rough pack, Cape Sheridan was rounded and the goal of the march reached at Cape Columbia, the most northerly point of Grant Land. There the last of a series of depôts was laid which will enable Amundsen, if his Polar drift brings him to the neighbourhood, to abandon his ship and travel southward by easy marches to the Danish settlements in Greenland.

THE first Pan-Pacific Scientific Conference met at Honolulu on August 2–20, when some noteworthy resolutions were carried (*Science*, September 24). Dealing with the promotion of scientific education, the conference recommended that the compensation for instruction and for research in science should be increased in order that young men may enter upon scientific careers without sacrificing all hopes of reasonable monetary returns; and, further, that men of exceptional attainments should be given rewards which may be comparable with those offered by commercial undertakings. A resolution was also passed advocating that efforts should be made to keep the public fully informed of the progress of science and of its bearings on the affairs of the world. Resolutions which concerned more nearly the institutes and universities of the Pacific countries dealt with the training of teachers and lecturers, with the provision of fellowships, and with the migration of research students to institutions providing the best facilities for their own class of work. The conference recommended that the exchange of teachers between institutes in different countries should be encouraged with the object of widening the outlook of these instructors. Fellowships to which adequate stipends were attached ought to be regarded as rewards for scientific work, and substantial prizes given as rewards for young investigators who achieve notable results. It was also agreed that a clearing-house of information relative to opportunities for scientific study and research in the Pacific area should be established.

SIR W. H. BRAGG delivered a public lecture at University College, London, on October 7, as a general introduction to the courses on the history of science to be delivered there. After referring to the origin of these courses, the lecturer said there must be something innate in mankind to prompt an interest in Nature and to foster a belief in cosmic order in spite of apparent chaos. Already in the earliest civilisations, in ancient Egypt and Babylonia, we see the beginnings of that close study of Nature which has continued with varying success throughout the ages. It is in the nature of things for old views to be superseded. There has, however, been more of evolution than of revolution in the history of scientific ideas. Each generation tries to correlate all the facts known to it, and it can do no more. Newton correlated all his facts; Einstein has to take into account facts unknown to Newton. There is no finality in science. A belief in finality would lead to stagnation. The history of science is interesting in many ways. It reveals the steps that have led up to our present orientation; it traces the evolution of the great scientific conceptions—like the atomic theory, for example; it shows the development of potent scientific instruments like the thermometer, etc.; it tells the story of the fruitful application of scientific discoveries—wireless telegraphy, for instance; it has the great human interest of showing how workers drawn from all sorts and conditions have co-operated in the building up of science; and it narrates many an inspiring epic of heroic struggle and perseverance, of triumph and tragedy, in the disinterested pursuit of noble ends. No wonder, then, that throughout the country there is awakening a new interest in the history of science. The subject offers a valuable educational opportunity. It merits the serious attention of teachers and journalists and all whose business it is to teach how things have come to be what they are; and it is well adapted to serve all those who seek to improve their education by non-vocational studies that will add to the interest and joy of life.

AMERICAN philologists have long been occupied in elucidating the complex of dialects spoken by the Indian tribes. The more important languages have been fully investigated, but there still remain some minor linguistic groups which are gradually coming under inquiry. The Tunica, Chitimacha, and Atakapa languages, spoken within historical times in territory now incorporated with the States of Mississippi, Louisiana, and Texas, form the subject of a monograph by Mr. J. R. Swanton, published as Bulletin 68 by the Bureau of American Ethnology. The first, the Tunica, is now spoken by only some half a dozen persons in a small reservation. For our knowledge of these languages, now practically extinct, we are indebted to Dr. A. S. Gatscher, whose collections were made in 1886, and further researches among the scanty survivors by Mr. Swanton have added little new information. This scholarly monograph gives a grammar and comparative vocabulary of these three closely allied forms of speech.

THE native tribes which occupied the vast region extending eastward from the Mississippi to the Atlantic are now understood to belong to at least seven linguistic stocks. Of these groups the Algonquian was the most numerous, followed by the Muskhogean, Iroquoin, Siouan, Timucuan, Uchean, and Tunican, all differing to such a degree that one would not have been intelligible to the other, and often within the same linguistic family the various tribes spoke different dialects. Thus such a diversity of languages and a great range of climatic conditions, mountains, prairies, swamps, and lakes produced a variety of customs influenced by natural conditions and environment. In perhaps no way are these variations more pronounced than in the forms of the dwellings of the various tribes. This subject is fully illustrated in the monograph (Bulletin 69) by Mr. D. I. Bushnell, jun., issued by the Bureau of American Ethnology. In this we have an investigation of ancient village sites occupied by the various tribes, and the nature of the buildings erected by peoples in various stages of culture, which is full of interest.

IN the September issue of the *Entomologist's Monthly Magazine*, Mr. F. W. Edwards deals with the habit of certain midges (Ceratopoginæ) of sucking the juices of other insects. This propensity has long been known, but Mr. Edwards's exact observations appear to be the first connected series conducted in this country. The blood-sucking habit among the females of this group of insects possibly first arose from the partiality of its members for attacking other insects. Few people who have used their gardens towards dusk have escaped the irritating punctures caused by these minute flies.

IN the Transactions of the Entomological Society of London (July, 1920) is a paper by Dr. G. D. Hale Carpenter on the forms and Acræine models of the Nymphaline butterfly, *Pseudacraea eurytus Hobleyi*, on the islands of Lake Victoria. Contained therein are some observations bearing upon the explanation of the theory of mimicry by natural selection. The object of the author is to show that in the presence of greater numbers of models the mimics are found to be true to type, but that when they outnumber the models many transitional and other varieties are preserved. The paper is a confirmation and extension of the author's earlier article published in March, 1914. The destruction of butterflies, so far as selective action is concerned, is held to be mainly the work of young birds which have to learn what to eat and what to avoid. Thus in 1914, when the models were extremely abundant, any member of a combination would have been more likely to be the distasteful Acræine. The young birds would therefore leave that combination alone, while varieties of the Pseudacræa not conforming to the model would be destroyed. As the birds grew older, and in localities where the models had become scarcer, one must suppose that the birds had forgotten what the latter tasted like, so that no one form of Pseudacræa had much more chance of surviving than any other. This explanation presupposes that the bird fauna stays on an individual island and does not fly from one to another. Dr. Carpenter has already brought forward some evidence which suggests that this is actually what does occur.

MESSRS. A. S. KENNARD AND B. B. WOODWARD have published in the Proceedings of the Malacological Society for September some "Nomenclatorial Notes relating to British Non-marine Mollusca." After discussing the names of various species of Testacella and Helix, they point out that the genotype of Ancylus is *Patella lacustris*, Linn., and that *Ancylus fluviatilis*, which belongs to a different genus, must be called Ancylastrum. This is a most unfortunate conclusion, because it is the latter species that has given the name to the well-known Ancylus Lake and Ancylus Clay of the late Glacial period in North-West Europe. Scarcely less regrettable is the authors' desire "to once again point out" that the name Bulinus is not available for "the Egyptian shells [*sic*] which play the part of host to Bilharzia," or, indeed, for any mollusc. They may be right, but we do not agree that because O. F. Müller adopted Adanson's pre-Linnean name Bulinus for four species, one of which was that imperfectly described by Adanson, his action "of course involves the acceptance of [Adanson's] shell as the type of the genus." The authors are so severe on Dr. Annandale for thinking that the name Bulinus (or Bullinus) ought to be preserved because of its wide currency, that one is astonished to find them, almost with the same penful, writing of Bilharzia, which they must know to be a synonym of Schistosoma. It is doubtless their misfortune rather than their fault that pages which blame the eccentric Fitzinger for neglect in proof-reading should themselves exemplify that form of carelessness.

FROM Buenos Aires we have recently received a copy of *El Hornero*, a journal of Argentine ornithology published by a recently established society, La Sociedad ornitológica del Plata, constituted for the encouragement of the study of the birds of the southern portion of South America. The journal derives its name *Hornero* from the Spanish word denoting one of the most characteristic birds of Argentina, known to Englishmen as the oven-bird and to science as *Furnarius rufus*, and an illustration of the birds and their curious massive nest built up of clay adorns the cover of each issue. The present number contains a carefully prepared list of the different species of penguins found along the coasts of Argentina drawn up by Señor R. Dabbene, the editor of the journal, and a list of 254 species of birds found in the neighbouring Republic of Uruguay from the pen of Señor J. Tremoleras, of Montevideo. Mr. A. G. Bennett, of Port Stanley, in the Falkland Islands, contributes some notes on the habits and distribution of the marine birds of that distant outpost of the British Empire, illustrated by reproductions of photographs taken by himself. The parasitic Mallophaga of the Argentine are treated of at considerable length by Dr. F. Lahille, who has himself described 31 out of the 159 species known to exist in the Argentine; and, finally, Prof. Lucas Kraglievich has an article on the fossil birds of the Republic, in which he discusses the relationship of Phororhacus with the recently-described Diatryma of the Eocene beds of the United States. There are a number of shorter articles and notes, with an ample bibliography of recent publications dealing with South American ornithology, and the general get-up and editing of the journal reflect great credit on the Sociedad ornitológica del Plata and the editor, Señor Dabbene.

MR. W. H. TALIAFERRO records (*Journ. Exper. Zool.*, vol. xxxi., No. 1, July, 1920) the results of observations on the reactions to light in *Planaria maculata*, planned with the object of ascertaining how far, in this Turbellarian, the function of the eyes in the reactions to light can be correlated with the histology of these organs. Hesse (1897), who worked with certain Triclads which were negative to light, and hence moved away from the source of stimulation, maintained that this reaction was due to the fact that the sensory cells or rhabdomes were shaded by the pigment-cup which partially enclosed them, whereas when the worm turned in any other direction the pigment-cup did not shade all the rhabdomes. When certain of the rhabdomes were illuminated, as in the latter case, the animal turned so as to bring the sensory region of the eye again into the shadow of the pigment-cup. Hesse therefore maintained that the localisation of the photic stimulus is the specific function of the pigment-cup, which enables the animal to direct its course away from the source of light. Mr. Taliaferro has carried out experiments on normal Planaria and on others from which one of the eyes, or a portion thereof, has been very carefully removed. He shows that the rhabdomes in the eye are arranged in two localised sensory regions. Illumination of one set is followed by the animal's turning towards the side containing the eye, while illumination of the remaining rhabdomes is followed by the animal's turning in the opposite direction. The observed reactions can be explained without assuming (with Hesse) that the pigment-cup acts as a localiser of photic stimuli. Light must strike a given rhabdome parallel to the long axis of the latter in order to cause stimulation; thus the position of the long axis of the rhabdome results in a localisation of photic stimulation. Light entering the pigment-cup from any given direction illuminates the rhabdomes in a definite area, and a large proportion of these have their long axes directed parallel to the stimulating rays of light.

We have received from Prof. H. F. Osborn reprints of some interesting brief notes on vertebrate fossils in the American Museum of Natural History, New York. A good drawing is published of a newly mounted skeleton of Moropus, the strange odd-toed hoofed mammal from the Miocene of Nebraska, in which the large hoofs are sharply pointed and deeply cleft as in some edentates (Proc. Nat. Acad. Sci., vol. v., pp. 250–52, 1919). Prof. Osborn concludes that this must have been a forest animal, and that the peculiar feet were used, not for digging, "but largely for the pulling down of the branches of trees." A drawing of a restored and mounted skeleton of a long-jawed mastodon (Megabelodon) from the Pliocene of Texas shows well the comparatively short limbs of the earlier elephant-like mammals (Proc. Nat. Acad. Sci., vol. v., pp. 265–66, 1919). Beginning apparently in northern Africa, these long-jawed mastodons reached Europe in Lower Miocene times, and appeared in America (Texas) in the Upper Miocene, attaining a gigantic size in the Middle Pliocene. The monograph of the Titanotheres is progressing, and Prof. Osborn describes some new fragments of jaws from the Eocene of Colorado (Bull. Amer. Mus. Nat. Hist., vol. xli., art. xv., 1919). The Jurassic Dinosaurs are also being actively studied, and some valuable notes on the original specimen of the gigantic sauropod, Camarasaurus, from Colorado, are published by Prof. Osborn and Mr. C. C. Mook (Proc. Amer. Philos. Soc., vol. lviii., pp. 386–96, 1919). The authors agree with Dr. W. J. Holland that the axis of the skull in the sauropods inclines downwards from the vertebral axis as an adaptation for browsing, and they give some striking restored sketches of the head of Camarasaurus as they think it appeared in life.

The Memoirs of the Geological Survey of India (vol. xlvii., part 1) contain an extremely interesting account of the mines and mineral resources of Yunnan by Mr. J. Coggin Brown. Yunnan is the most southwesterly of the provinces of China, and is of importance from the British point of view because it forms the eastern boundary of Burma and Assam; it has been but little visited by Europeans, and Mr. Coggin Brown's explorations thus afford authentic information upon an extensive area which has hitherto been most imperfectly studied. The more important mineral products which he has described comprise coal, iron, copper, lead, silver, zinc, tin, arsenic, gold and salt. In addition to Tertiary lignite, coal of Mesozoic, Triassic and Carboniferous age is known, and the author is of the opinion that the province contains considerable quantities of coal, some of which, at any rate, is of good quality. He does not think there is much probability that coal can be exported in competition with other coalfields of the Far East, but holds that it will find its chief demand in supplying the local railways and local domestic and metallurgical requirements. Iron ores occur in many places, and the production of cast-iron, castings, wrought iron and steel is sufficient for all local requirements, which are, of course, by no means extensive. The native methods of iron-smelting are well described, and it is interesting to find that the Chinese have developed charcoal blast-furnaces 25 ft. in height and 7 ft. across the boshes. The author does not think that there is much room in Yunnan for the development of iron-smelting upon modern European lines, but that the native smelters will gradually learn to improve their own methods. It is stated that copper has been smelted in Yunnan for at least a thousand years, but although copper ores are widely distributed the industry appears to be a declining one. The same seems to be true of lead and silver, but the production of tin, on the other hand, is in a flourishing condition.

Some interesting facts showing the limits of the continental United States which have been compiled by the United States Geological Survey are published in *Science* of September 24. The gross area of the United States is 3,026,789 square miles, of which 2,973,774 square miles are land and the remainder, 53,015 square miles, water; this is exclusive of the area occupied by the Great Lakes and that within the three-mile limit on the Atlantic and Pacific seaboards and in the Gulf of Mexico. The most southerly point of the mainland is Cape Sable, Florida, which is in latitude 25° 7′ N. and longitude 81° 5′ W.; this point is really forty-nine miles further south than the southernmost point of Texas, which often appears in maps to be the most southerly part of the land territory of the United States. The most easterly point is West Quoddy Head, near Eastport, Maine, in longitude 66° 57′ W. and latitude 44° 49′ N.; and the most westerly Cape Alva, Washington State, in longitude 124° 45′ W. and latitude 48° 10′ N. A small detached land area of northern Minnesota provides the most northerly point, in longitude 95° 9′ W. and latitude 49° 23′ N. The distance from the most southerly point of Texas due north to the forty-ninth parallel, the boundary line between the United States and Canada, is 1598 miles. From West Quoddy Head due west to the Pacific Ocean is 2807 miles, while the shortest distance from the Atlantic to the Pacific across the United States is 1152 miles, measured from the neighbourhood of Charlestown, South Carolina, to San Diego, California. The Canadian boundary line from the Atlantic to the Pacific is 3898 miles in length; the Mexican, from the Gulf of Mexico to the Pacific, 1744 miles. The Atlantic coast-line measures 5560 miles, the Pacific 2730 miles, while that washed by the Gulf of Mexico is 3640 miles in length.

Blue Hill Meteorological Observatory has issued its observations and investigations for the year 1919 as vol. lxxxiii., part 4, of the Annals of the Astronomical Observatory of Harvard College, U.S.A. The work has been done under the direction of Prof.

Alexander McAdie. Consecutive observations have now been published for thirty-four years. Atmospheric pressure, air temperature, vapour pressure, relative humidity, cloudiness, wind direction and velocity, and precipitation are given twice daily, at 8 a.m. and 8 p.m., throughout the twelve months, and the means and totals are entered for each month with the differences from the normals for the thirty-four years, 1886 to 1919. Wind frequency is given for each month and for the year for each 45° of the compass, and the mean and highest wind velocity. The duration of sunshine and the percentage of the possible amount are also included. Phenomena showing the advance of the season for each of the thirty-four years are given, such as thawing of ponds, last snowfall and last frost in spring, first blossom and first ripe fruit, first snowfall in autumn, and ponds frozen. There are numerous constants and averages for the thirty-four years, such as days with snow, hail, thunderstorms, and fog. Rainfall and snowfall and mean temperatures for each month of the thirty-four years are entered in tables. In the introduction a slip has been made in transposing the references to tables ix. to xi. A detailed description is given by Prof. McAdie of "a quick method of measuring cloud heights and velocities," which will doubtless be useful at aerographic stations.

Batavia Observatory has issued a volume of 140 pages, giving in detail the meteorological and magnetical observations for 1915, and also the meteorological results for the several months for the fifty years 1866 to 1915 and the means for the whole period. The work is published by the Government of East India, under the supervision of Dr. W. van Bemmelen, the director. For half a century hourly observations of many of the elements have been uninterrupted. A change has been made in the position of the barometer during 1915 which reduces the daily range of temperature of the attached thermometer from 5° C. to only a few tenths of a degree—an important factor when searching for the diurnal range of atmospheric pressure. For wind velocity the factor 3 has been used as formerly for the reductions, but it is found that the true factor decreases with the increasing velocities of wind. The results for fifty years probably give in many cases means which will vary little by any increase in the length of the period, but the fifty years may contain cycles the means for which may differ considerably among themselves. Rainfall results are given for fifty-two years, and breaking these into two periods of twenty-six years, the monthly averages are very different. Roughly speaking, the rainfall for the latter twenty-six years, 1890–1915, has increased in the southern winter months and decreased in the southern summer months. Magnetical observations are given only for 1915; there are curves showing the monthly deviations of the magnetic components from the mean yearly values.

The Report of the Committee on the Standardisation of the Elements of Optical Instruments just issued by the Research Department contains much information of prime importance to instrument-makers. It fixes standard focal lengths and diameters for telescope objectives, angles of prisms for binoculars, and diameters of tubing and of screws and pitches of the latter. It strongly advocates interchangeability amongst the products of the different manufacturers, and points out that two years ago the screws nominally of the same size turned out by one optical firm only in the country were interchangeable amongst each other. That firm has in a most public-spirited way offered to supply the chasers and gauges necessary to secure interchangeability. The adoption by the Committee of the inch as the unit of length will not permit of the principle of interchangeability being extended to instruments of Continental manufacture.

In the September issue of the Journal of the Franklin Institute Dr. F. E. Pernot has written an interesting and important paper on submarine-cable signalling. Dr. Pernot gives the results of experiments carried out by the members of the Signal Corps Research Laboratory of the U.S. Bureau of Standards. Several successful attempts were made to increase the carrying capacity of a submarine cable by superposing an alternating current on the existing system of direct-current signals. It is pointed out that currents of several frequencies can be used simultaneously, as each message can be separated by a suitable tuning device. The author is to be congratulated on having determined the physical constants of a submarine cable at various frequencies, both by calculation and by experiment. It is shown that the design of suitable apparatus becomes a straightforward problem. Actual trials of these methods with cables as long as 700 km. were made, the results being in all cases completely satisfactory. With longer cables difficulties were experienced, but the experiments indicated that it was possible to superpose at least one alternating current on the existing duplex system of an Atlantic cable. From the theoretical point of view it is interesting to note that the high-frequency resistance of a submarine cable is greater than that computed by Kelvin's formula. The effects of the steel armouring and the uncertainty in the position of the return currents would probably account for this. It was found that 5 microvolts at the receiving end gave good signals with the powerful amplifiers which are now available.

"The Gases Dissolved in Water" formed the subject of the Streatfeild memorial lecture delivered by Mr. J. H. Coste at the Finsbury Technical College on October 14. In a brief historical sketch reference was made to the work of Henry, Dalton, and Bunsen on the estimation of gases dissolved in water, and to that of Dittmar in connection with the *Challenger* Expedition. Curves were shown to illustrate the results of Adeney's work on the rate of aeration of air-free water, and reference was made to the investigations of Tornøe, Winkler, Roscoe, and Dittmar on the variation with temperature of the volumes of gases dissolved in water, results being given for distilled water and sea-water. The absorption coefficients determined by Bohr and Bock were given, and a curve depicting the manner in which solubility of oxygen in water falls with rise of temperature was shown. A method of collecting samples from any depth was illustrated, and Winkler's method for estimating the volume of dissolved air in water explained. The lecturer referred to the utility of this work in such diverse fields as public health and oceanography, and indicated the importance of dissolved air to subaqueous plant and animal life. The function of submerged green plants in absorbing carbon dioxide and liberating oxygen was explained, and it was stated that large quantities of oxygen in excess of saturation were found after a period of plant activity in bright light. One function of this dissolved oxygen is to maintain a healthy condition in water by oxidising submerged refuse—a process largely dependent upon the presence of living organisms. Reference was also made to geological changes due to dissolved carbon dioxide, to hardness produced by the same gas, and to the corrosive action of water containing dissolved air as exemplified by the oxidation of ironwork in hot-water radiators, and by the corrosion observed in all steam-raising systems owing to the oxygen dissolved in the feed-water. At the close of his lecture Mr. Coste referred in eloquent terms to the work done at Finsbury College during the past thirty-five years, and deplored the fact that the closing of the college was contemplated.

Engineering for October 8 gives some interesting particulars regarding fabricated ships constructed in the United States. It will be remembered that these ships were so arranged as to permit the separate parts to be manufactured by a large number of firms and then assembled at the shipyard. The fabricated freighter has now been afloat long enough to experience sufficiently varied conditions to reveal its seaworthiness. It is a known fact that steamers of this kind have been able to forge ahead in the teeth of storms that have driven larger boats of the usual build to leeward. Replacements in cases of breakdown or injury have been made very promptly. Two steamers, one of which was a fabricated vessel, collided, and each smashed a hawse-pipe; the fabricated vessel was repaired from stock in a few hours, whilst repairs to the other ship took six weeks. Reports made by masters and chief engineers reveal the soundness of the hulls and their unusual tightness and freedom from leakages in the cargo-bilges, etc. Up to April 1 of the current year 120 fabricated craft had been launched from the twenty-eight ways of the Newark Bay shipyard, the keel of the first having been laid in December, 1917—a feat which constitutes a record. It is proposed to carry on this yard, and the Submarine Boat Corporation has taken it over from the Government. The programme provides for extensive developments of both the yard and its neighbourhood, with the idea of making that point a highly equipped port of entry and departure, with dry docks and other repair conveniences.

WE learn that the X-ray and electro-medical business of the High Tension Co. has been purchased by X Rays, Ltd. Arrangements have also been made whereby Mr. Mortimer A. Codd, the author of a well-known book on the subject of high-tension apparatus, becomes the director of research for X Rays, Ltd. The direct association of an X-ray research laboratory with a manufacturing firm has yielded such astonishing results in America that one may look with confidence to the similar plan which has been initiated in this country.

WE are informed that the head offices of Siemens Brothers and Co., Ltd., and of Siemens Brothers Dynamo Works, Ltd., will be removed shortly from Palace Place Mansions, Kensington, London, W.8, to Caxton House, Westminster, London, S.W.1.

Our Astronomical Column.

THE NOVA IN CYGNUS.—This object has continued to decline in brilliancy at a fairly steady rate. Mr. Denning writes that since the end of August the star has lost light at a rate equivalent to one-tenth of a magnitude daily. The nova has exhibited features differing in several respects from those of the bright novæ of 1901 (Perseid) and 1918 (Aquilid), which showed remarkable fluctuations in their declining stages and presented phenomena analogous to those of ordinary variable stars. It seems, in fact, as though the new stars of 1901 and 1918, after their great outburst and quick decline, were subject to a series of minor outbursts affecting them at short and fairly regular intervals.

No such disturbances have apparently been observed in the case of Nova Cygni. At Bristol, during the fifty-five nights from August 20 to October 13 inclusive, the star was observable on forty-seven nights, and it has now become a rather faint telescopic object, its magnitude on October 7 being only 8¼.

It is remarkable that since 1848 twelve new stars have been discovered which were visible to the naked eye, although during the preceding 150 years not one nova was recorded.

CONNECTION OF PLANETARY NEBULÆ WITH HELIUM STARS.—*Astr. Nach.*, No. 5065, has an article by Herr H. Ludendorff on this subject. Herr Ludendorff alludes to the puzzling fact that the planetary nebulæ show a high average velocity in the line of sight, while the helium and Wolf-Rayet stars, with which they have spectroscopic affinity, have a conspicuously low one. It was at first thought that the number of nebulæ on Keeler's list, which was twelve, might be insufficient to deduce a trustworthy mean. But the publication of a much larger list of ninety-six nebulæ by Campbell and Moore has increased the mean radial velocity from 25 to 30 km./sec. It becomes very difficult to make any plausible scheme of cosmogony into which these nebulæ will fit. The low radial velocity of the helium stars is generally explained by their large mass on the assumption that the law of equipartition of energy applies to stellar velocities. There is, however, evidence of considerable mass in the case of the planetary nebulæ also. Campbell noted spectroscopic evidence of rotation in several cases. Combining these with van Maanen's parallaxes, Herr Ludendorff finds values for the masses of four planetaries as 14, 19, 162, and 28, that of the sun being unity. In view of this difficulty, he re-examines the evidence that spectroscopic binary systems give of the masses of the B stars, and states that it appears that those with the largest mass have also the largest radial velocity, and that the same rule appears to hold for the Wolf-Rayet stars.

While this result may help to bridge the gulf between the planetaries and kindred types of stars, it only removes one difficulty to create another. It remains to give a reasonable explanation of the increase of velocity with mass, which is quite opposed to preconceived ideas.

Our Conceptions of the Processes of Heredity.*

By MISS E. R. SAUNDERS, F.L.S.

II.

THE behaviour of the sex-chromosomes as here outlined suffices to account for the occurrence of sex-linked inheritance, but the relations found to hold between one sex-linked character and another need further explanation. If a cross is made involving two sex-linked characters, the F_1 females when tested by a double recessive male are found to produce the expected four classes of gametes, but not in equal proportions, or in the same proportions in the case of different pairs of sex-linked characters. Partial linkage (coupling) occurs of the kind which has already been described for the stock and the sweet pea. The parental combinations predominate, the recombinations ("cross-overs") comprise the smaller categories. The strength of the linkage varies, however, for different characters, but is found to be constant for any given pair. Since the sex-linked factors are by hypothesis carried in the sex-chromosomes, a clean separation of homologous members at meiosis should result in the characters which were associated in the parents remaining strictly in the same combination in each succeeding generation. The fact that this is not the case has led Morgan to conclude that an interchange of chromosome material must take place at this phase among a proportion of the gametes, and that the percentage of these "cross-overs" will depend on the distance apart of the loci of the factors concerned. This phenomenon of linkage may also be exhibited by pairs of characters which show *no* sex-linkage in their inheritance. The factors involved in these latter cases must presumably, therefore, be disposed in one of the chromosomes which is not the sex-chromosome.

To this brief sketch of the main points of Morgan's chromosome theory must be added mention of the extremely interesting relation which lends strong support to his view, and the significance of which seems scarcely to admit of question, viz. that in *Drosophila ampelophila* there are four pairs of chromosomes, and that the linkage relations of the hundred and more characters investigated indicate that they form four distinct groups. It is scarcely possible to suppose that the one fact is not directly connected with the other. The interesting discovery of Bridges (*Journ. Exper. Zool.*, vol. xv., 1913) that the appearance of certain unexpected categories among Drosophila offspring, where females of a particular strain were used, coincided with the presence in these females of an additional chromosome adds another link in the chain of evidence. On examination it was found that in these females the X chromosome pair occasionally failed to separate at the reduction division, and, consequently, that the two XX chromosomes sometimes both remained in the egg, and sometimes both passed out into the polar body. Hence there arose from fertilisation of the XX eggs some individuals containing *three* sex-chromosomes, with the resulting upset of the expectation in regard to sex-limitation of characters which was observed.

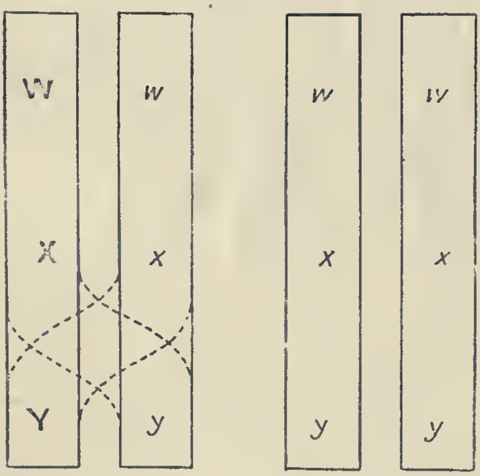
It, however, remains a curious anomaly that in the cross-bred Drosophila male no corresponding crossing-over of linked characters, whether associated with the sex-character or not, has yet been observed. His gametes carry only the same factorial combinations which he received from his parents. For this contrast in the behaviour between the sexes there is at present no explanation. The reverse condition has been described by Tanaka (Journ. Coll. Agr., Sapporo, Japan, 1913–14) in the silkworm. Here interchange takes place in the male, but not in the female.

It must, then, be acknowledged that Morgan's interpretation of the cytological evidence has much in its favour. The striking parallel between the behaviour of the chromosomes and the distributional relations of Mendelian allelomorphs is obvious. The existence in *Drosophila ampelophila* of four pairs of chromosomes and of four sets of linked characters can scarcely be mere coincidence. The employment of the smaller physical unit in accounting for the reshuffling of characters in their transmission commends itself in principle. The necessity for postulating the occurrence of some orderly irregularity in the hereditary process in order to explain the phenomenon of partial linkage is, it will be seen, inherent alike in both theories. When, however, we come to examine the general applicability of Morgan's theory, we are confronted with a considerable body of facts among plants which we find difficult to reconcile with the requirement that factorial segregation is accomplished by means of the reduction division. An instance in which this is particularly clearly indicated is that of the sulphur-white stock. I have chosen this example because here we have to do with two characters which are distinguished with the utmost sharpness, viz. plastid colour and flower form. The peculiar behaviour of this strain is due to the fact that not only are the two factors for flower form (singleness and doubleness) differently distributed to the male and female sides of the individual, as in all double-throwing stocks, but the factor controlling plastid colour likewise shows linkage with the sex-nature of the germ-cells. As a result every individual, even though self-fertilised, yields a mixed offspring, consisting chiefly of single whites and double creams, but including a small percentage of double whites. So far as the ovules are concerned, the mode of inheritance can be accounted for on either theory. According to the reduplication hypothesis, the factors XY, producing singleness, and W, giving white plastids, are partially coupled so as to give the gametic ratio on the female side 7 WXY : 1 WX*y* : 1 *wx*Y : 7 *wxy* (or possibly 15 : 1 : 1 : 15).[1] On the chromosome scheme the factorial group WXY must be assumed to be disposed in one member of the bivalent chromosome formed at meiosis, the corresponding recessive allelomorphs *wxy* in the other. If the three factors be supposed to be arranged in the chromosome in alphabetical order, and if, on separation, a break take place between the loci of the two factors for flower form (as shown), so as to give "cross-overs" of Y and *y* in about 12 per cent. of the gametes, the occurrence of such "cross-overs" would fulfil the required conditions. But the case of the pollen presents a distinct difficulty on this latter view. The sulphur-white stock is distinguished from both the Drosophila and the Abraxas type by the fact that none of the male germs carry either of the dominant characters. In place of the XX—XY form of sex-linked inheritance in the former type and the WZ—ZZ in the latter, we should need to regard this form as constituting a new class, which we might represent as DR—RR, thus indicating that both members of the bivalent chromo-

* From the opening address of the President of Section K (Botany) delivered at the Cardiff meeting of the British Association on August 24. Continued from p. 227.

[1] The letters X and Y are used here to denote particular factors, not, as in Morgan's scheme, the entire sex-chromosome.

some on the male side appear to be inert and able to carry only the recessive characters, and hence are represented as RR, in contrast with the DR pair of the female side. By this formula we can indicate the behaviour of the several double-throwing strains. It is, besides, becoming clear, I think, from recent results that there is no "crossing-over" of these factors on the male side in the F_1 cross-breds. But the real difficulty is to explain why these factors are confined to the female side in the ever-sporting individual. This may result from aberrant behaviour or from loss of chromosomes at some point in pollen development. On this point I hope that evidence will shortly be available. Failing such evidence, the presumption is that the elimination of XY (and in one strain of W) must have taken place *prior to*, and not *at*, the moment of the maturation division. Morgan's proposal to fit the pollen into his scheme for Drosophila by having recourse to hypothetical lethal factors does not appeal to the observer, who finds the pollen all uniformly good and every ovule set. Other examples suggesting premeiotic segregation can be quoted, notably cases among variegated plants and plants showing bud sports, where somatic segregation appears to be of regular occurrence.



Ovules Pollen

It has been argued from time to time that any scheme representing the mechanism of heredity which leaves out of account the cytoplasm must prove inadequate. This general statement has been expressed in more definite form by Loeb ("The Organism as a Whole," 1916), who holds that the egg cytoplasm is to be looked upon as determining the broad outlines—in fact, as standing for the embryo "in the rough," upon which are impressed in the course of development the characteristics controlled by the factors segregated in the chromosomes. The arguments in favour of the view that the cytoplasm, apart from its general functions in connection with growth and nutrition, is the seat of a particular hereditary process are mainly derived from observation upon embryonic characters in certain animals, chiefly Echinoderms, where the inheritance appears to be purely maternal. It has been shown, however, that such female prepotency is no indication that inheritance of the determining factors takes place through the cytoplasm. Other causes may lead to this result. It has been observed, for example, that hybrid sea-urchin larvæ, which at one season of the year were maternal in type, at another were all paternal in character, showing that the result was due to some effect of the environment. Again, where the hybrid plutei showed purely maternal characters it was discovered by Baltzer (*Archiv für Zellforschung*, vol. v., 1910) that in the earliest mitoses of the cross-fertilised eggs a certain number of chromosomes fail to reach the poles, and are, consequently, left out of the daughter nuclei. The chromosomes thus lost probably represent those contributed by the male gamete, for in both parents certain individual chromosomes can be identified owing to differences in shape and size. After this process of elimination, those characteristic of the male parent could not be traced, whereas the one pair distinctive of the female parent was still recognisable. In the reciprocal cross where the first mitosis follows a normal course the embryos are intermediate in regard to the character of the skeleton, thus affording proof of the influence of the male parent. Another type of case is found in the silkworm. Here a certain rate-character determining the time of hatching out of the eggs has been shown to exhibit normal Mendelian inheritance, the appearance that it is transmissible by the female through the cytoplasm alone being delusive. The eggs are always laid in the spring. According as they hatch out immediately so that a second brood is obtained in the year or do not hatch out for twelve months, the female parent laying the eggs is described as bivoltin or univoltin. Now the length of interval before hatching is obviously an egg-character, and therefore maternal in origin. Consequently, when a cross is made between a univoltin female and a bivoltin male the eggs laid are not cross-bred in respect of this character, any more than the seed formed as a result of a cross is cross-bred in respect of its seed-coat, which is a maternal structure. The silkworm mother being univoltin, the eggs will not hatch out until the following spring. The F_1 mother will, in turn, lay eggs which again take twelve months to hatch, since the long-period factor is the dominant. It is not until the eggs of the F_2 generation are laid that we see the expression of the character introduced by the bivoltin father. For some of the egg batches hatch at once, others not for twelve months, showing that of the F_2 females some were univoltin and some bivoltin, and hence that the egg-character in any generation depends upon both the maternal and the paternal antecedents of the female producing the eggs.

Consequently, in the case of an egg-character the effects of inheritance must be looked for in the generation succeeding that in which the somatic characteristics of the zygote become revealed. We find, in fact, that in almost all instances where the evidence is suggestive of purely cytoplasmic inheritance, fuller investigation has shown that the explanation is to be found in one of the causes here indicated. The case of some plants where it has been established that reciprocal hybrids are dissimilar still, however, remains to be cleared up. We know nothing as yet of the cytology of these cases, and it is not improbable that the interpretation may be found in some aberrant behaviour of the chromosomes. An instance in a plant type where a definite connection appears traceable between chromosome behaviour and somatic appearance has been recently emphasised by Gates (*New Phytologist*, vol. xix., 1920), who attributes the peculiarity of the *lata* mutation in Œnothera (which has arisen as a modification at different times from each of three distinct species) to an irregularity in meiosis in the germ mother-cells whereby one daughter-cell receives an extra duplicate chromosome which is lacking in the sister-cell. The cell with the extra chromosome fertilised by a normal germ produces a *lata* individual. On the chromosome view every normal fertilised egg contains a double set of chromosomes, each carrying a complete set of the factor elements. Hence, if some of the one set become eliminated, we can still imagine that a normal, though undersized, individual might develop. The converse relation, where increased size goes with multiplication of chromosomes, was discovered by Gregory (Proc. Roy. Soc., B, vol. lxxxvii., 1914) in a Primula, and occurs also in *Œnothera gigas*, a mutant derived from *Œ. Lamarckiana*. It is interesting in this connection to recall the results obtained by Nemec (*Jahrb. f. wiss. Bot.*, xxxix., 1904, "Das Problem der Begruchtungsvorgänge," 1910) as the result of subjecting the root-tips of various plants to the narcotising action of chloral hydrate. Under this treatment cells undergoing division at the time were able to form the daughter nuclei, but the production of a new cell-wall was inhibited. The cells thus became binucleate. If on recovery these cells were to fuse before proceeding to divide afresh a genuine tetraploid condition would result. So few cases of natural tetraploidy have thus far been observed that we have as yet no clue to the cause which leads to this condition.

The conclusions to which we are led by the considerations which have here been put forward are, in the main, that we have no warrant in the evidence so far available for attributing special hereditary processes to the cytoplasm as distinct from the nucleus. On the other hand, there is a very large body of facts pointing to a direct connection between phenotypic appearance and chromosomal behaviour. In animals the evidence that the chromosomes constitute the distributional mechanism may be looked upon as almost tantamount to proof; in plants the observations on Drosera, Primula, Œnothera, and Sphærocarpus are in harmony with this view. When we come, however, to the question of linkage and general applicability of the conception of "crossing-over" as adopted by Morgan and his school, we are on less certain ground. In Drosophila itself, the case which the scheme was framed to fit, the entire absence of "crossing-over" in the male remains unaccounted for, while the evidence from certain plant types appears to be definitely at variance with one of its fundamental premises. If segregation at the recognised reduction division is definitely established for animal types, then we must conclude that the sorting-out process may follow a different course in the plant.

The question as to what is the precise nature of the differences for which the Mendelian factors stand is constantly before the mind of the breeder, but we are only now on the threshold of investigation in this direction, and it is doubtful whether we can as yet give a certain answer in any single instance. Still less are we able to say what the actual elements or units which undergo segregation may be. In the case of such allelomorphic pairs as purple and red sap colour or white or cream plastid colour, it may be that the difference is *wholly qualitative*, consisting merely in the formation or non-formation of some one chemical substance. But the majority of characteristics are not of this hard-and-fast type. Between some the distinction appears to be one of *range*—to be quantitative rather than, or as well as, qualitative in nature, and range must mean, presumably, either cumulative effect or a force or rate difference. It may well be, for example, that with some change in physiological equilibrium accompanying growth and development, factorial action may be enhanced or accelerated, or, on the other hand, retarded or even inhibited altogether, and a regional grading result in consequence. Range in a character is not confined to, though a common characteristic of, individuals of cross-bred origin. It may be a specific feature, both constant and definite in nature. For example, a change as development proceeds from a glabrous or nearly glabrous to a hairy condition is not an unusual occurrence in plants. In the stock such a gradational assumption of hairiness is apparent no less in the homozygous form containing a certain weak allelomorph controlling surface character, when present with the factors for sap colour, than in those heterozygous for this or some other essential component. We see a similar transition in several members of the Scrophulariaceæ, *e.g.* in various species of Digitalis, in *Antirrhinum majus*, *A. orontium*, *Anarrhinum pedatum*, Pentstemon, and Nemesia. In perennials an annual recurrence of this change of phase may be seen, as in various species of Viola and in *Spiraea ulmaria*. In some, perhaps in all, of these cases the allelomorphs may stand for certain states of physiological equilibrium, or such states may be an accompanying feature of factorial action. A change of phase may mean an altered balance, a difference of rhythm in interdependent physiological processes. In the case, for instance, of a certain sub-glabrous strain of stock in which the presence of a single characteristically branched hair or hair-tuft over the water-gland terminating the midrib in a leaf otherwise glabrous is an hereditary character, it is scarcely conceivable that there is a localisation in this region of a special hair-forming substance. It seems more probable that some physiological condition intimately connected with the condition of water-content at some critical period is a causal factor in hair production, and that this condition is set up over the whole leaf in the type, but in the particular strain in question is maintained only at the point which receives the largest and most direct supply. In this same strain a leaf may now and again be found lacking this hydathode trichome in an otherwise continuous hair-forming series, an occurrence which may well result from a slight fluctuation in physiological equilibrium such as is inherent in all vital processes—a fluctuation which, when the genetic indicator is set so near to the zero point, may well send it off the scale altogether. If, as is not improbable in this and similar cases, we are concerned with a complex chain of physiological processes, investigation of the nature of the differences for which the allelomorphs stand may present a more difficult problem than where the production of a particular chemical compound appears to be involved. In such a physiological conception we have probably the explanation of the non-appearance of the recessive character in certain dominant cross-breds.

Up to this point we have treated of the organism from the aspect of its being a wholly self-controlled, independent system. As regards some characteristics, this may be regarded as substantially the case—that is to say, the soma reflects under all observed conditions the genetic constitution expressed in the Mendelian formula. Correspondence is precise between genotypic potentiality and phenotypic reality, and we have so far solved our problem that we can predict certainly and accurately the appearance of offspring, knowing the constitution of the parents. In such cases we may say that the efficiency of the genetic machine works out at 100 per cent., the influence of external environment at 0. Our equation somatic appearance = factorial constitution requires no correction for effect of conditions of temperature, humidity, illumination, and the like. But most somatic characters show some degree of variability. Phenotypic appearance is the outcome primarily of genotypic constitution, but upon this are superposed fluctuations, slight or more pronounced, arising as the result of reaction to environmental conditions. In the extreme case the genetic machinery may, so to speak, be put out of action; genotypic potentiality no longer becomes actual. We say that the character is not inherited. We meet with such an example in *Ranunculus aquatilis*. According to Mer (Bull. Soc. Bot. de France, i., 27, 1880), the terrestrial form of this plant has no hairs on the ends of the leaf-segments, but in the aquatic individual the segments end in needle-shaped hairs—that is to say, hairs of a definite form are produced in a definite region. Again, Massart (Bull. Jard. Bot. Bruxelles, i., 2, 1902) finds that in *Polygonum amphibium* the shoot produces characteristic multicellular hairs when exposed to the air, but if submerged it ceases to form them on the new growth. Every individual, however bred, behaves in the same manner, and must therefore have the same genetic constitution. In an atmospheric environment genotypic expression is achieved; in water it becomes physiologically impossible. A limitation to genotypic expression may in like manner be brought about by the *internal* environment, for the relation of the soma to the germ elements may be looked upon in this light. Thus in the case of a long-pollened and round-pollened sweet pea, Bateson and Punnett (Report to the Evolution Committee, Roy. Soc., ii., 1905) found that the F_1 pollen-grains are all long, yet half of them carry the factor for roundness. If we take the chromosome view, and if it be presumed that the factor for roundness is not segregated until the reduction division, the cytoplasm of the pollen mother-cells may be supposed to act as a foreign medium owing to a mixture of qualities having been impressed upon it through the presence of the two opposite allelomorphs before the moment of segregation. We should, consequently, infer that the round-pollen shape is produced only when the round-factor-bearing chromosome is surrounded by the cytoplasm of an individual which does not contain the long factor. If, further, we regard the result in this case as indicative of the normal interrelation of nucleus and cytoplasm in the hereditary process, we shall be led to the view that, whatever the earlier condition of mutual equilibrium or interchange between these two essential cell constituents may be, an ultimate stage is reached in which the *rôle* of determining agent must be assigned to the nucleus.

In conclusion, I would appeal for more organised co-operation in the experimental study of genetics. It is a not uncommon attitude to look upon the subject of genetics as a science apart. But the complex nature of the problems confronting us requires that the attacking force should be a composite one, representing all arms. Only the outworks of the fortress can fall to the vanguard of breeders. Their part done, they wait ready to hand over to the cytologists, with whom it lies to consolidate the position and render our foothold secure. This accomplished, the way is cleared for the main assault. To push this home we urgently need reinforcements. It is to the physiologists and to the chemists that we look to crown the victory. By their co-operation alone can we hope to win inside the citadel and fathom the meaning of those activities which take shape daily before our eyes as we stand without and observe, but the secret of which is withheld from our gaze.

The Air Conference, 1920.

THIS Conference, consisting of representatives of aviation in all its many branches, lasted three days, and was organised by the Air Ministry in order to bring together persons interested in the subject in conditions under which urgent problems could be freely discussed with the knowledge that resolutions of the conference arrived at after such discussion would be welcomed by the Ministry as assisting the Secretary for Air in his endeavour to promote in every way the national interests depending on aeronautics.

At the luncheon at which he presided on the first day of the conference, Mr. Churchill, Secretary of State for War and Air, made this abundantly clear. The future of military aviation, he pointed out, depended on the widespread development of civil aviation. "We," he continued—"I am speaking for the Government—intend to help civil aviation by every means in our power. You know our resources are limited, but I hope the day is coming when it will be possible for us to increase to some extent the resources which are available for the development of civil aviation. I do not think three years should be too much to reconstruct the Air Service, so that fathers of every grade in our national life shall be glad to send their sons into it with the feeling that they are giving them a good start in life, with the possibility of a fine career."

In the main (he added), civil aviation must fly by itself, and the function of the Government would be to facilitate its action—to liberate, stimulate, and encourage its action. The Air Estimates had shortly to be considered. He excluded no solution which would be likely to help us through the two or three difficult years ahead of us. No one could have the slightest doubt about the ultimate future. To suppose that the world, having got into the air, was ever going to get out of it, was as absurd as to suppose that the world, having taken to steamships, was going back to schooners and sailing ships. They were gathered there to drive away pessimism and to assert their view that a great and bright future was opening for British aviation.

The conference was held, by the courtesy of the Lord Mayor, in the council chamber of the Guildhall on October 12, 13, and 14, and the room was well filled during all the sessions. The Lord Mayor himself welcomed the members, and in a few well-chosen words expressed his sense of the importance of the occasion. He then gave place to Lord Montagu of Beaulieu, whose interest in aviation is known to all. On the second day Lord Weir of Eastwood, President of the Air Council during a most critical part of the war, presided; while on the third day the chairmen were, in the morning, Lord Beatty and, in the afternoon, Lord Londonderry, Under-Secretary of State for Air, who had been detained in Ireland and was unable, in consequence, to be present at the opening sessions.

The business details were admirably arranged. A paper was read by some recognised authority on the subject under discussion, one or two invited speakers followed, and then the discussion was open to all who cared to contribute.

The conference was fortunate in that three out of the six papers were read by the members of the Air Council responsible for the subjects considered, while other members of the Council took part in the discussion. The audience thus learnt at first hand official views on these matters.

The conference was widely representative; invitations had been sent not only to airmen, to designers and builders of aircraft of all kinds, and to the representatives of aeronautical organisations, but also to the Air Attachés of foreign Powers, to members of learned societies, to representatives of various Government Departments, and to the secretaries of the Transport Workers' Federation and of the United Vehicle Workers.

Turning now to the details of the meeting, the first day was devoted to civil aviation and air services and to the operation of civil aircraft in relation to the constructor.

Major-Gen. Sir Frederick H. Sykes, Controller-General of Civil Aviation, was the author of the first paper. He dealt in detail with the growth and present position of air-mail goods and passenger services (*a*) in the United Kingdom, (*b*) between London and the Continent, (*c*) in foreign countries, and (*d*) in the British Dominions and Colonies. Under (*b*) he gave a most valuable series of statistical tables, showing the amount and type of the general traffic, the number of arrivals in and departures from the United Kingdom, the number of letters carried, customs returns, and the number of accidents. Details as to the last were very striking; the dangers of air traffic are quite small, and it was stated during one of the discussions that all the accidents for some time, so far as could be known, had originated in the failure of the engine or of one of the engine accessories.

A large map brought clearly before the eyes of all the routes actual and projected, and information was given with regard to the proposed services from Paris to Prague, Warsaw, and the Balkan States, and from London to Copenhagen, Hamburg, and Scandinavia. The importance of Egypt to the Imperial routes to Africa and the East was very clearly shown. This point was stressed later by Sir Hugh Trenchard in his paper.

The second part of Sir F. Sykes's paper dealt with the factors contributing to successful air services, and the author concluded a most valuable contribution with suggestions for the future development of those services. Referring to the recommendations of Lord Weir's Advisory Committee on Civil Aviation, he said that the more experience he obtained and the more he considered the case in regard to the scheme of subsidies which Lord Weir's Committee recommended, the more clear he was that those recommendations were sound. He appreciated the argument in favour of allowing industry to stand on its own feet, but he was strongly of opinion that civil aviation must not be allowed to die for lack of direct assistance, the need for which would only be temporary, that was to say, during the period—three to five years—during which old material was being used up, and while new and really suitable types were being evolved. Without this small stimulus it would be very difficult for transport concerns to show enterprise and vigour, even if they could live during the next year or two.

The conference was greatly indebted to Mr. White Smith, the able and energetic chairman of the Society of British Aircraft Constructors, for his paper in the afternoon. After discussing the present lack of financial success in operating air services and its main causes, and emphasising the need for improved trustworthiness, while pointing out the high standard already attained, Mr. Smith proceeded to give a series of most important statistics as to the costs of operating commercial air services, showing the capital expenditure involved in the use of various types of aircraft, the operating costs, and the necessity of improved design as shown by the operating costs.

The tables which accompanied the paper will, no doubt, be published in full, and, while they may need correction in some details—Mr. Handley Page in the course of the discussion did criticise some of the figures relating to one of his machines—they form a most valuable mine of information and must prove of immense service. The economic advantage of the large high-powered machine is very clearly brought out.

The second day was devoted to research. Between the morning and afternoon sessions on that day a most interesting visit was paid to the Croydon Aerodrome to see the arrangements for the departure and arrival of aircraft to and from the Continent and to learn something of the working of an air-port. A large number of the most modern types of machine were on view, and many members had their first flight.

Lord Weir was in the chair, as was specially fitting, for during his tenure of office as President of the Air Council he appointed a Committee on Education and Research, and thus led up to the scheme connected with the Zaharoff professorship which is now being developed at the Imperial College.

Air Vice-Marshal E. L. Ellington's paper gave a full account of the present position of aircraft research and contemplated developments—questions which, as Director-General of Supply and Research, he was specially qualified to discuss. He dealt in the case of aircraft heavier than air with trustworthiness, controllability, performance, safety and comfort, and cheapness. Particulars were also given as to airships and kite-balloons.

Capt. Barnwell, in the afternoon, dealt very fully with the technical aspects of Service and civil aviation. In the course of the discussion reference was made to the important work carried out during the war by the scientific staffs of the Royal Aircraft Establishment and the National Physical Laboratory, and the fear was expressed lest the reductions which had taken place at Farnborough were on such a scale as to impair the efficiency of the research work. It was also pointed out by several speakers that, in addition to a research staff in the scientific establishment, it is essential that builders of aircraft should be in a position to retain the services of a staff of skilled designers, whose work is necessary before the results of research can be made use of in improved machines.

During the afternoon session two resolutions were moved and carried *nem. con.* The first, moved by Major-Gen. Sir R. Ruck, was to the effect "That the Air Conference of 1920 desires to record its emphatic opinion that the rapid development of civil aerial transport is vital to the interests of the Empire, not only as a means of developing its communications, but also as an essential element in its defence, and the conference endorses the recommendations of Lord Weir's Advisory Committee on Civil Aviation and urges their adoption by the Government"; while the second, moved by Prof. Bairstow, urged that sufficient means for researches, both in the Government establishments and elsewhere, should be provided, and that steps should be taken to enable constructors to retain the services of a number of skilled designers.

On the first day a resolution had been carried urging that certain mails should be conveyed by air.

The work of the third day was no less interesting and important. In the morning Air-Marshal Sir H. M. Trenchard, Chief of the Air Staff, spoke on the aspects of Service aviation, the problem of war in the air. He discussed at some length the prospects of young officers in the Force, pointing out that all cannot be taken on permanently, and suggesting that in some cases four years in the Force might take the place of the university. In conclusion, he said that the power of aircraft to cover great distances at high speed, their instant readiness for action, their independence of physical communications, their indifference to obstacles, and the inability of an enemy unprovided with an Air Service to counter their attack, combined to encourage their use more often than the occasion warranted. The power to go to war at will was apt, in fact, to result in a thoughtless application of that power.

In the afternoon session Sir Trevor Dawson dealt with the future of airships. He thought there would be no difficulty in producing ships to travel at eighty miles an hour, thus giving an average speed, allowing for the wind, of sixty miles, and expressed the view that there would be no difficulty in running a regular trans-oceanic service once the trustworthiness and saving of time had been demonstrated. In his opinion, the time to the Cape might thus be reduced from eighteen days to five, and that to India from sixteen days to four or five.

Sir James Stevenson, Civil Member of the Air Council, stated towards the end of the discussion on behalf of the Ministry, and he thought he might say on behalf of the Government, that if a commercial syndicate would offer to take their airships and develop them as a national undertaking, it would be an easy matter to get the Government to agree to give them not only airships, but also aerodromes and the other assets.

A further resolution was passed asking the Government to reconsider the report of the Civil Aerial Transport Committee and the recommendations it contained with the view of adopting such as might now apply.

The conference, which was remarkable in many ways, closed with the usual votes of thanks, and in replying, Lord Londonderry, chairman at the concluding session, expressed the appreciation of the members for the help afforded by the Press.

There is no doubt that aviation, particularly civil aviation, will benefit from the discussions which have taken place, and still more from the fuller consideration which can be given to the papers when published in full. The hope was expressed by many that the conference may become an annual event, and thus afford a regular opportunity for the ventilation of questions of great public interest. R. T. G.

Annual Report of the Meteorological Committee.[1]

THE Report of the Meteorological Committee for the year ending on March 31 last marks the end of a definite stage in the development of the British State Meteorological Service. During the year under review four notable developments occurred: (1) The Office became attached to the Air Ministry instead of being in direct connection with the Treasury; (2) the work of the British Rainfall Organization was incorporated with that of the Office; (3) the co-ordination of the Services of the Navy, Army, and Air Force, which developed during the war, was begun; and (4) inter-Dominion and international co-operation in meteorology, which had largely been in abeyance during the war save for military purposes, began to take a more definite shape. One might add as a fifth important occurrence that the period of service of Sir Napier Shaw as Director of the Office came to an end at the close of the year, though he consented to remain in office until the appointment of his successor was carried through.

An appendix to the report gives the recommendations of the Sub-Committee of the Research Committee of the Cabinet which was appointed to lay down principles on which the State Meteorological Services should be reorganised. It is satisfactory that the wisdom of having one State organisation has been realised, and that while the constitution of the Committee provides for adequate representation of public Departments, the Royal Society and the Royal Society of Edinburgh are also represented. The constitution of the Committee provides that the Controller-General of Civil Aviation shall act as its chairman, but on the representation of the Royal Society it was agreed that a vice-chairman should be elected from amongst the representatives of scientific societies. The Director of the Office, who under the old *régime* was chairman of the Committee, ceases to be a member, but "will act generally as adviser to the Committee on all meteorological and geophysical subjects," and is made responsible for bringing before the Committee "all matters of importance relating to the application, progress, and development of the science of meteorology in which the Meteorological Service might share."

The British Rainfall Organization had a separate existence for sixty years, but it had for some time been evident that incorporation with the growing State Service was desirable, and indeed necessary. On the retirement of Dr. H. R. Mill from active duty as Director of the Organization, the transfer was carried through. Mr. Carle de S. Salter, who was associated with Dr. Mill, has been appointed superintendent of the rainfall work of the Committee, so that the continuity of the work and of the relations with voluntary observers is assured.

The overlapping of the various Meteorological Services which developed during the war was perhaps more apparent than real, but there cannot be two opinions as to the need for co-ordination under a central authority. The Navy, the Army, and the Air Force each had quite distinct and separate needs which were met by separate establishments, but the only serious overlapping which occurred arose from the creation of separate headquarters in London, provided with a staff for forecasting, and each collecting similar information. This overlapping has now, fortunately, disappeared, and a start has been made with the establishment of local civil distributive stations to take the place of war-time stations for supplying to aircraft, shipping, and the general public information derived from detailed study of the weather in a form suitable for practical use. One interesting development in this connection is the provision of an effective local organisation for Scotland, with headquarters in Edinburgh and a local advisory committee.

The effect of the war in bringing to light the value of meteorological information is well gauged by the increase in the *personnel* of the Office. In 1914 the staff of the Office comprised about 20 professional and 60 clerical and technical assistants, while on March 31, 1920, the establishment was 97 professional staff and 278 clerical and technical staff.

The inter-Dominion and international arrangements are still far from being stabilised, but one of the most important developments was a Conference of Dominion meteorologists, which concluded with the following resolution: "That this conference of representative meteorologists of the British Empire assembled together for the first time agree to continue as an association for the exchange of their views from time to time by correspondence upon scientific matters concerning the achievements, requirements, and organisation of their Services, and hereby elect Sir Napier Shaw their first president, and invite the members to submit rules for the guidance and acceptance of the

[1] Fifteenth Annual Report of the Meteorological Committee to the Lords Commissioners of His Majesty's Treasury for the Year ended March 31, 1920. Pp 88. (Cmd. 948.) (London: H.M. Stationery Office, 1920.) Price 9*d*. net.

association." This conference had been preceded by the international meeting in Brussels of representatives of the scientific academies of the Allies, at which meteorology was amongst the subjects considered. A Geodetic and Geophysical Union was set up, one of its branches being meteorology with Sir Napier Shaw as chairman and Dr. Marvin (of the U.S. Weather Bureau) as secretary. A meeting in Paris followed, summoned by the French Government, at which a new international meteorological committee was appointed, with Sir Napier Shaw as president, in continuation of the old committee. A further complication arises out of the convention relating to aerial navigation, which formed part of the work of the Peace Conference, and by Annexe G regulates "the collection and dissemination of statistical, current, and special meteorological information."

What shape international co-operation may ultimately take is sufficiently obscure, but it is satisfactory to know that Sir Napier Shaw, who has been responsible for so great a development in the past, is to continue to act as president of the new International Committee.

E. M. W.

Proposed British Institute for Geodetic Training and Research.[1]

By DR. E. H. GRIFFITHS, F.R.S., and MAJOR E. O. HENRICI.

GOOD maps are necessary for the development of a country, for such purposes as defining property boundaries, limits of mining and other concessions, and so on, as well as for such engineering purposes as railway, road, and canal schemes, hydro-electric schemes, water-supply, irrigation, etc. The importance of good charts, as well as of trustworthy information as to tides and currents, scarcely needs emphasising. An incorrect or out-of-date chart will cause losses due to delays to shipping, even if it does not lead to more direct loss. Anything that will assist in the production of up-to-date and accurate charts is of great and direct benefit to the shipping industry, and through it to the nation. Even when such work has once been completed there is no finality, as both maps and charts require periodical revision at more or less frequent intervals, according to circumstances.

The economical and speedy production of such maps and charts necessitates a thorough knowledge of the principles on which all survey work is based and of the best means of applying such principles under varying conditions. Apart from revision work, there is still a great deal of survey work waiting to be carried out, enormous areas still exist in the Empire which are surveyed very inadequately or not at all.

Very large sums have been misapplied in the past owing to a lack of appreciation of the principles which should underlie all survey work. The Egyptian Survey of 1878–88 cost some 360,000*l.*, and produced incomplete maps of some 2000 square miles. Almost the whole of the work had to be repeated in 1892–1907, when, owing to the adoption of proper methods, and in spite of many difficulties, some 13,000 square miles were satisfactorily mapped at a cost of less than 450,000*l.*

The methods to be adopted depend upon circumstances, the nature of the country, and the objects of the survey. The difficulties to be overcome vary in different parts of the world. The experiences of the various surveyors have been published in their records and reports, but these are not in an easily accessible form, nor is there any general index or summary to be found. The originals are circulated to a limited number of persons and institutions, and buried in libraries, even if their existence is not forgotten. When a new difficulty arises in any survey it has to be tackled *de novo*, though it is quite likely that similar circumstances have arisen before. In such a case it is probable that the surveyor in question does not know of it; and, even if the reports are accessible to him (which they frequently are not), the actual information he wants is most effectually buried. This leads to much waste of effort, as there is no central body to which he can refer.

As regards existing departments and institutions, the Dominion, Indian, and Colonial Surveys are all independent, and, broadly speaking, train their own staff. There are, however, good survey schools in some of the Dominions. The Ordnance Survey produces its well-known maps, which are revised periodically, and they are so complete that no extensive survey work is required by outsiders in this country. This accounts for the lack of attention paid to the subject outside Government Departments, but the result has been that the development of the science of surveying has largely stagnated in this country, the centre of the Empire.

There is, therefore, a distinct need for a school and institution in which students can be trained in the principles of survey work, and where the subject is studied as a whole. This school would also serve as a central information bureau, enabling the scattered surveyors of the Empire to keep in touch with developments, and to which they could apply for information and assistance.

It might seem at first sight that this could and should be undertaken by a Government Department, but this is scarcely possible for various reasons. There is no central authority which deals with the Government Surveys of the Empire, though a link is kept between the Colonial (as distinct from the Dominion) Surveys by the Colonial Survey Committee. The various Surveys and Departments naturally have to consider their own immediate needs first; they are usually short of funds, and consequently not in a position to carry out the work now being discussed. Even if a central authority were formed for this purpose, it could deal only with Government Surveys, and could not train surveyors and engineers for private work.

There seems little doubt that most of the Government Surveys would welcome a school from which they could recruit their staff and an institution to which they could apply for information, and which could keep them in touch with the activities and progress in other parts of the world.

The existence of such an establishment would also encourage the production of improved designs of instruments and the production of new time-saving devices; there have been many such improvements of late years, but mostly from abroad, *e.g.* invar tapes and wires for base measurement (France) and an improved levelling instrument (Germany). There are also many developments in view which require working out, *e.g.* the use of wireless time-signals for the determination of longitude in the field, survey from aircraft, etc. At present makers have little

[1] From an address on "The Urgent Need for the Creation within the Empire of a Central Institution for Training and Research in the Sciences of Surveying, Hydrography, and Geodesy," delivered to a joint meeting of Sections A and E at the Cardiff meeting of the British Association on August 27.

inducement to bring out new and improved patterns of instruments; their largest customers are engineers, who, as a rule, have had a very elementary training as surveyors, and are shy of adopting any new instrument or method.

The above remarks apply particularly to land surveying, but are largely true also of hydrographic work. India and Canada have their own Hydrographic Services, but apart from these the Hydrographic Department of the Admiralty has to deal with all the seas and coasts of the Empire, and also with such others as are not dealt with by their own Governments. The task is great, and the resources available are all too small for the work. Even in home waters there is much to be done, if only due to the changes continually taking place in all estuaries. Apart from the shifting of sandbanks, etc., much of the earlier work is not up to the standard of modern requirements.

There is no school where hydrographic surveyors can receive instruction in the principles and theory of their work, and no staff available for studying methods and instruments and bringing them up to date. The hydrographic staff of the Admiralty is recruited from volunteers amongst the younger officers of the executive branch of the Royal Navy who have passed in navigation. They learn their surveying in the surveying ships while work is in progress, and the staff of trained surveyors is at present so limited that it can give little instruction to the beginners. Many officers after serving in a surveying ship for two or more years return to ordinary duties afloat, or specialise in other branches where their knowledge of survey work is of great benefit to them. The remainder are advanced in rank *pari passu* with the officers of H.M. Fleet. The existence of a school where the theoretical side of the question could be studied would be of great benefit to all.

The principles involved in survey are the same whether applied by land or by sea, and the instruments largely the same. One establishment could usefully study and give instruction in both sides of survey work.

Survey cannot be carried out over large tracts of country without consideration of the science generally known as geodesy, which is really only survey as applied to the earth as a whole. The problems involved in this require not only world-wide data, but also high mathematical skill. Problems interconnected with these are those concerning the tides and terrestrial magnetism, both of great importance to navigation. These, again, are connected with the study of the earth's structure in its wider sense, and so with seismology and geology. These problems may all be summed up in the word "geophysics."

While a knowledge of geophysics is not necessary for every surveyor, no survey authority can function satisfactorily without it. At the same time few such authorities have the staff available for its proper study. A central institution which could be referred to for information would add greatly to the efficiency of the survey authorities.

The need for a British geodetic institute is admitted by all who are acquainted with the nature and importance of the pressing Imperial and scientific problems which depend on the great surveys. The study of such problems has hitherto been left, in characteristic British fashion, to the initiative of enthusiastic individuals or neglected altogether. Take, for example, the case of the tides—so vital a matter to our sailors. While the late Sir George Darwin still lived it could at least be said that one master-mind was devoted, with some approach to continuity, to the study of the great problems which must be attacked and solved if tidal prediction is to advance beyond its present elementary and scrappy state, but since his lamented death in 1912 the subject has lacked attention.

At the request of the British Association, Prof. H. Lamb recently reviewed the whole situation with regard to tides, and in a masterly report indicated the number and importance of the problems awaiting solution. Problems comparable in insistence are connected with the land surveys of our Empire, and a similar review of the general situation, also initiated by the British Association under the stimulus of war, directed attention to the pressing need for some determined effort to attack them. The report opened with this cogent sentence: "There is no institution, association, or department whose business it is to deal with the higher geodesy." Consideration of the report by a special committee, afterwards enlarged, developed in the direction of urging the establishment of a geophysical institute. The need for such an institute has been formally recognised as urgent by the Conjoint Board of Scientific Societies (formed during the war for the study of urgent questions), which appointed a small executive committee (which included the president and secretary of the Royal Society) to press for the immediate establishment of such an institute.

We think it would be difficult to find in any scientific matter greater unanimity amongst all the authorities concerned therein. We trust that sufficient evidence has been given as to both the national importance of the subject and the urgency of the need for action. We await the advent of the *vivus benefactor*, for, as already indicated, there is a consensus of opinion that such an institution should be established within a university by private benefactions, although assistance might, as a consequence, be forthcoming from national funds. The wide ramifications of survey, geodesy, and geodynamics into mathematical, physical, and engineering sciences call for their study in a university rather than in a departmental atmosphere.

The Imperial College as a University of Science and Technology.[1]

THE real issue is whether a useful and worthy type of university can be erected on the comparatively narrow basis of a limited group of studies. In both primary and secondary education there has been a growing tendency to evolve several distinct types of school. Is it only university cloth that must always be cut to the same pattern? If we consider the enormous complexity of modern civilisation and the degree and extent to which it is based upon science, we must think that, in the region of university education, the time has come for a further differentiation of functions, and that the first step in this development should be the creation of a new type of university based upon pure and applied science, not to supersede, but to supplement, the existing type. The normal type of university, embracing a great number of faculties, would still remain, and ought to be, the predominant and prevalent type.

Science, pure and applied, from its nature, is worthy to rank in educational and cultural values with other

[1] Synopsis of a paper on "The Proposed University of Science and Technology: Can a Useful and Worthy University be Based on Pure and Applied Science?" read before the Old Students' Association of the Royal College of Science on October 12 by J. W. Williamson.

university studies. It is qualified not less by its extent to form a foundation neither flimsy nor narrow for a university superstructure. During the past half-century science has developed not only intensively, but also so extensively as to cover vast fields of knowledge previously undreamt of. The result has been the creation of new sciences, differentiated by their own specialised literature, methods, instruments, practitioners, and societies. The step from a faculty of science in a university to a university of science and technology is in line with the steps that have given us to-day separate professors of inorganic chemistry, organic chemistry, physical chemistry, and metallurgy in place of the one-time professor of chemistry whose ambit included all these subjects.

The Imperial College was styled "Imperial" with deliberate intention from the first. From its charter it is clear that it is set to perform real university work of the highest order in science and technology. There is, moreover, a special need which the Imperial College is peculiarly marked out to fill, but which it cannot do adequately unless it has the status of a university with the power to confer degrees. A large and increasing number of students from the overseas Dominions, after completing their courses in the Dominion universities and technical colleges, go to Europe or America to take up what is essentially post-graduate scientific work, especially in its application to industry. The courses of the Imperial College completely satisfy their needs in this direction, better probably than those of any university in the United Kingdom, but the college in its present status cannot give to such overseas graduates who go through the full post-graduate courses anything more than the college diploma. On the other hand, Zurich and some American and German cities have institutes of technology granting degrees. It has already been pointed out that in the industrial and professional worlds the university degree is recognised as a hall-mark and has a commercial value. The consequence is that there is a growing tendency among these overseas graduates and scientific students to go to America instead of to England, so that they may have a veritable and recognised technological degree, and not a mere diploma, to show for the work they do; and the Imperial College is thus being starved of a type of student it was deliberately charged at its foundation to receive and train. The loss, and even the danger, to the Empire of such a tendency are obvious.

Such a university of science and technology would be the keystone of the arch of our technical colleges and polytechnics; it would influence and enlarge the conceptions of technical and scientific education throughout the country and the Empire; and it must be of great benefit to the modern industrial research movement by raising the status of technological science, by pouring out a stream of the most highly trained technologists and research workers, and by being the natural head and crown of the national recognition, so long and disastrously delayed, of the vital importance of scientific research, especially in its application to industry.

There is nothing intentionally or inherently injurious to the University of London or to any other university in the proposal to give a university status to the Imperial College. To propound as a sort of unalterable principle that for Greater London, with a population as large as that of Canada and twice as large as that of Switzerland, there must be one, and only one, university savours rather of an academic dogma than of a balanced educational perspective. The Imperial College and the University of London should be set free to work out each its own future independently of the other. They have divergent aims and interests, and it would be an injurious mistake to force them into an unworkable *mésalliance.*

Agriculture in Egypt and Cyprus.

Agricultural operations in Egypt are entirely dependent upon the Nile, and all extensions in the direction of taking fresh land into cultivation depend upon the way in which more profitable use can be made of the waters of the Nile and of the fertilising mud that it carries with it. The construction of the Aswan reservoir has rendered it possible to retain much of the flood-water, but even now a large amount is wasted that would aid in the expansion of the cultivated area if it could be conserved. Mr. G. C. Dudgeon (Bull. Imp. Inst., vol. xvii., No. 3) sets forth a statistical estimate of the possible and available water-supply, together with the theoretical annual consumption of water for the chief crops. It is suggested that if certain proposed schemes of reclamation were carried out, the whole water requirements of Egypt would be met by less than 60 per cent. of the mean annual discharge of the Nile.

Under the auspices of the Egyptian Ministry of Agriculture, special attention is being given to the various problems of crop and animal husbandry with the view of improving the agriculture of the country (*Agricultural Journal of Egypt*, vol. ix., 1919). The war emphasised the local needs, and revealed deficiencies in many directions, especially in labour, animals, and manures. Motor-tractor ploughing is now advocated, and the adoption of machine-threshing would result in better quality grain and flour, as the present native system introduces a large percentage of mud into the product which cannot be removed by any known mechanical means. As cattle manure is being used more and more as fuel, increased production is now dependent chiefly upon the use of chemical fertilisers, and there are possibilities that if cheap sulphuric acid could be produced, an appreciable supply of sulphate of ammonia and superphosphate could be turned out. Attempts are being made to improve the chief crops, and experiments with various rust-resisting Australian wheats show that some of these offer distinct possibilities for Egyptian agriculture, and are worthy of further trial.

The most important crop is cotton, so much so that the tendency is to increase the area devoted to it at the expense of that utilised for food production, and it is now necessary to import a larger proportion of food than in earlier years. The area under cotton increased steadily to a maximum in 1914 at a greater rate than the total cultivated area, but for the last twenty-three years the average yield per *feddan* has steadily decreased. This, curiously enough, is attributed chiefly to the improvement in the water-supply. The increased water-supply has not been accompanied by sufficiently increased drainage; the soils become saturated and the subsoil-water remains at a high level—a condition of things that is most unsuitable for the satisfactory growth of the cotton plant. Further, the additional supply of water has rendered possible the extension of cotton-growing to new lands which are less fertile than those which have been longer under cultivation, and the lower yields obtained have reduced the general averages. The varieties grown also influence the yield, as many recently introduced ones, possessing other very desirable qualities, give smaller crops than the older kinds.

Since its comparatively recent introduction into Egypt the pink boll-worm, *Pectinophora* (*Gelechia*) *gossypiella*, has so rapidly increased that it has for some years been the chief insect pest of cotton. Much scientific work is being done on its life-history and on its effect on the cotton crop with the view of attacking the pest in the most effective manner, as it may now be classed on a par with the Phylloxera of vines for destructiveness. Field experiments indicate that the effect of Gelechia attack may be rendered less harmful by reducing the water-supply in July and stopping it altogether after the first week in August, as by this means the yield of cotton is increased and the crop ripens earlier.

During the last sixteen years the farmers of Cyprus have exhibited an enlightened and receptive attitude towards modern agricultural methods, with the result that considerable improvements have taken place in the agriculture of the island. These changes are set forth by Mr. W. Bevan in the Bulletin of the Imperial Institute (vol. xvii., No. 3, pp. 302–58), and the resources and possibilities of the island are briefly summarised. About 1,200,000 acres are under cultivation, but another 770,000 acres are either under forest or could be cultivated. The average rainfall is about 20 in. per annum, and the climate, especially in the plains, shows considerable extremes of temperature. Agriculture is the main industry, but methods and appliances are behind the times, though improvements are being effected through the activities of the Agricultural Department. Irrigation is essential, and if a satisfactory solution of the water problem could be reached, large fertile areas which now have to remain fallow could be brought under cultivation for growing cotton and other similar crops and for extending vegetable and fruit culture. A considerable amount of stock-raising is carried on, sheep-rearing being an important industry. Cheese and butter are made from sheep's and goat's milk, largely for home consumption, though some is exported to Egypt. Poultry-farming could be made very profitable, as the climate and food-supply are suitable, but ignorance of proper management at present hinders the industry from prospering.

The chief cereals grown are wheat, barley, and oats, though maize and rye have been introduced during the last few years. Fruit-growing is of much importance, and the export trade in this respect is considerable, some amount of wine and spirits also being produced and sent abroad. Market-gardening is receiving much attention, as there is a good demand in Egypt for fresh vegetables which are raised round the "ports" of Cyprus.

Heredity and Eugenics.

DR. R. RUGGLES GATES contributes to the latest number of the *Eugenics Review* a valuable essay on heredity and eugenics. "Probably in no other species of animal or plant does the number of differences between individuals approach the number to be observed in man." "It has now become a commonplace of observation that the *differences* between organisms, as well as their resemblances, are often inherited." Heredity includes both the entailment of parental variations and the possibility of new variations. A very interesting survey is taken of the inheritance of both physical and mental characters in man. Eugenic action should include, if only there were sufficient knowledge, (1) positive selection for desirable qualities, which are frequently dominant; (2) negative selection against undesirable recessive qualities which appear in collateral or ancestral lines, and may therefore be carried in the family germplasm; (3) isolation of individuals having undesirable dominant qualities; and (4) an effort to foster matings between individuals showing the same desirable recessive quality. Another interesting feature of Dr. Ruggles Gates's paper is the discussion of the question whether there are any details of structure so small or of such a nature as to be beyond the reach of hereditary entailment. Some good examples are given of the continuance of very minute structural idiosyncrasies. As regards the inbreeding and outbreeding of human races, the author concludes that intermixture of unrelated races is from every point of view undesirable. "The more advanced race is diluted and degraded by such intermixture." "The blend is only a blend when considered *en masse*." On the other hand, interbreeding of related races or strains gives increased vigour.

University and Educational Intelligence.

ABERDEEN.—The Lord Rector, Lord Cowdray, will deliver his address in the Mitchell Hall on October 23.

Dr. J. B. Orr, director of the Rowett Research Institute, has been appointed research lecturer in the physiology of nutrition for the ensuing academical year, and Mr. R. H. A. Plimmer, chief biochemist, re-appointed research lecturer in applied biochemistry.

CAMBRIDGE.—Mr. S. M. Wadham, Christ's College, has been appointed senior demonstrator in botany, and Mr. R. E. Holthum, St. John's College, junior demonstrator.

LONDON.—In response to a request made by many of those who attended Dr. Jeffery's public lecture on Einstein's theory of relativity, a course of eight lectures on the same subject by Dr. Jeffery has been arranged at University College. The course will begin on Monday, October 25, at 6 p.m.

A course of ten public lectures on "The Development of Philosophy from Descartes to Leibniz" is being given at King's College by Prof. H. Wildon Carr on Tuesdays at 5.30 p.m. The course commenced on October 12.

OXFORD.—The new academical year has begun with a very large number of fresh entries. The colleges are almost inconveniently full, and most of the scientific departments are overcrowded. The activities of the teaching staff of both University and colleges are being taxed to the utmost. A contributing cause of the present pressure upon the resources of accommodation and teaching is the influx of women students, who are now to be seen in the academic costume lately devised for their use.

On October 14 a new departure was taken by the admission of nearly sixty women to degrees; these included the conferring of the degree of M.A. by decree on the Principals of the women's colleges and halls and of the Society of Oxford Home-Students.

A letter has been addressed by some members of the University to the professors of the arts and sciences and to members of the universities and learned societies in Germany and Austria, expressing a "desire to dispel the embitterment of animosities that under the impulse of loyal patriotism may have passed between us," and suggesting that a reconciliation may surely be looked for in the fields of arts and learning.

MR. J. R. C. GORDON has been appointed professor of materia medica and therapeutics at the Anderson College of Medicine, Glasgow.

The new session of the Aristotelian Society will be inaugurated on Monday, November 8, at 8 o'clock, when the president, Dean Inge, will give an address on "Is the Time Series Reversible?" The meeting will be held in the Conference Hall of the University of London Club, 21 Gower Street, W.C.1.

Free public lectures on physic will be delivered by Sir Robert Armstrong-Jones at Gresham College, Basinghall Street, E.C.2, at 6 p.m., on November 8, 10, 11, and 12. The subjects of the lectures will be "The Air We Breathe," "The Houses We Live In," "The Clothes We Wear," and "The Food We Eat."

The *British Medical Journal* for October 16 states that the University of Heidelberg has received 500,000 marks from Herr F. Behringer, of Bielenfeld, for the erection of an institute for the study of the chemical constitution of albumin. Until the institute is completed the researches will be carried on in the physiological institute under the direction of Prof. Kossel.

We learn from *School Life* for August 15 last that Mr. August Heckscher, of New York City, has given 500,000 dollars to Cornell University to maintain professorships of research and to provide facilities for scientific work. The persons selected for such positions will be relieved of routine teaching and administrative details in order that they may be free to devote themselves to scientific investigation and to the training of future investigators.

On October 18 the report of the Higher Education Sub-Committee on London University was adopted at a special meeting of the Education Committee of the London County Council. Mr. H. C. Gooch said that, having obtained an assurance from the President of the Board of Education that acceptance of the Bloomsbury site for the headquarters of the University would not close the door against grants from Treasury sources towards the building and equipment of the new premises, the Sub-Committee felt justified in recommending the Education Committee to ask the Council to make a conditional building grant. He moved: "That, subject to satisfactory arrangements being made between the Government and the Council of King's College for the reinstatement of King's College on the proposed Bloomsbury site, and in the event of the University of London accepting the site in Bloomsbury referred to in Mr. H. A. L. Fisher's letter dated April 7, 1920, and provided that adequate grants are made by the Government for the erection of administrative buildings on the new site, the Council is prepared to consider an application for a building grant for this purpose subject to the condition that the Council's contribution shall not exceed one-third of the contribution made by the Government in respect of expenditure not exceeding 1,000,000*l.*, and that the Council be recommended accordingly." The resolution was adopted by eighteen votes against five.

The Y.M.C.A. Universities Committee, of which Dr. D. H. S. Cranage is chairman and the Rev. Basil A. Yeaxlee secretary, has issued an admirable educational handbook for the guidance of secretaries and for providing suggestions for the building up of local educational programmes for the various branches of the Y.M.C.A. according to their respective needs. There has been established with this object an education department at the headquarters of the association, 13 Russell Square, W.C.1, from which further advice and guidance can be obtained. It is proposed to establish throughout the kingdom divisional areas connected with the local branches of the Y.M.C.A., each with its educational committee representative not only of the members, but also of the local educational activities, whether official or voluntary. The movement is chiefly concerned with the supply of adult education, the emphasis upon which should lie largely with non-vocational subjects such as religion, history, sociology, science, literature, the arts, and physical education, the technical and vocational studies being offered only when other educational agencies fail to provide them. It is earnestly advocated that one of the greatest needs of our country to-day is a democracy with the power to think and to form judgments, people who have the country's welfare at heart and are prepared to take their place as citizens, understanding clearly the implications and duties of citizenship. Having this purpose in view, the National Council has asked the universities and other bodies co-operating with the association in its war-time educational work to continue to send representatives to form the Y.M.C.A. Universities Committee, and the response has been cordial and complete, a body being formed comprised of eighty-five members representative of all the universities and the university colleges of Great Britain and other voluntary agencies. Well-defined lecture and tutorial courses upon a variety of subjects are arranged, including philosophy, history and geography, literature, art, religion and morals, economics, music and the drama, and suggestions for correspondence groups, for the formation of libraries, and for summer and week-end schools are offered.

From the *Pioneer Mail* for August 13 last we learn that an extraordinary meeting of the Senate of Allahabad University was held on August 7, at which Sir Harcourt Butler, Chancellor of the University, presided. In opening the debate, the Chancellor said that the policy in the United Provinces for higher education was the development of a number of universities of the unitary, residential, and teaching type. The first step in this direction was the establishment of an institution on these lines at Lucknow, and a Bill had been prepared and published which aimed at putting into force the recommendations of the Lucknow University Conference. The second step was that the line between university and school teaching should in future be drawn at the intermediate stage. This involved the re-organisation of secondary education. To this end it was proposed to establish a Board which would supersede the existing School-leaving Certificate Board, and be entrusted with the task of providing the preparation for university work now given in the intermediate classes of the college, and of developing a system of high secondary education. The third step to be accomplished was the re-organisation of Allahabad University. It should be divided into two parts, one, internal, being a self-contained unitary, residential, and teaching university, and the other, external, consisting of affiliated outlying colleges. In conclusion, it was pointed out that primary, secondary, and technical education would not be in any way retarded by lack of finances should the schemes for university reform be adopted. A discussion followed, and the Senate passed a resolution, moved by Dr. Sapru, approving the general scheme for establishing a university at Lucknow, but reserving its opinion as to details. Motions were also passed by which the draft Bill for the establishment of a Board for High School and Intermediate Education, and the report of the committee on the re-organisation of Allahabad University, should be referred to a Select Committee.

In Bulletin No. 50, 1919, of the United States Bureau of Education an account is given of the condition of science teaching in the schools of

Memphis, Tennessee. The bulletin is divided into four sections, dealing with the elementary schools, the central high school, the vocational high school, and the high school for coloured children. In the elementary grades no science or Nature-study enters into the curriculum. At the central high school instruction is divided into eight groups, according to the principal subject taken: Latin, history, science, modern languages, commerce, technical training, home economics, and a course in which any subjects may be taken. In five of these groups no science studies are essential; in one, one science subject is necessary, in another two are required, and in the remaining one five are compulsory. However, in six of the groups either four or five sciences are voluntary, and another offers three "elective" sciences, but in the commercial group no science studies are undertaken. The number of students actually taking scientific subjects amounts to only 28·7 per cent. of the total number of pupils on the books, and measures are suggested for ensuring that a greater number obtain some training in science. Part of the scheme suggested is that general science should be taught in the upper classes of the elementary schools. The number of teachers employed in teaching science, and in many cases their qualifications, appear to be quite inadequate to the task before them. At the vocational high school shop-work is prominent, but it is surprising to note that there are no laboratories equipped for work in science, and no teachers apparently who are competent to teach such subjects. In the high school for coloured children the condition of scientific studies is even worse; it is impossible to do anything but text-book and recitation work, and even this is done only with great difficulty on account of the constant overcrowding of the room. The whole school is reported as unclean and insanitary and in a pitiable condition.

A COPY of the regulations and syllabus of the British School of Malting and Brewing for the year 1920–21 has been received. The school is a department of Birmingham University, and deals with all branches of applied biochemistry, especially as applied to fermentation industries, to agriculture, and to sanitation. Four courses of instruction are provided—a degree course, a diploma course, a part-time series of lectures for brewers and maltsters leading to a certificate, and special short courses on malting and brewing. The lectures for the degree are recommended to students desirous of qualifying as chemists or bacteriologists in industries in which biochemistry plays an important part. A fourth year's work in the department of brewing qualifies a graduate for the diploma in that science. The diploma course is intended for students leaving school who desire training in the principles of malting, brewing, and other fermentation industries. The first two years are devoted to general scientific training as a preparation for the technical work of the third year, which consists largely of acquiring a practical knowledge of brewing and of the methods used by brewers in the judgment and valuation of barley, malt and other requisites of the trade. The part-time course for brewers and maltsters is open to all, but to qualify for the University certificate the candidate must have had two years' practical experience in brewing or malting. The ground covered is similar to that dealt with in preparation for the diploma, but the laboratory work does not go so far into the scientific side of the operations. The short courses provided are intended for those who find themselves unable to attend any of the above classes; such students share all advantages equally with diploma students. A time-table and syllabus of each course are given in the booklet. It is interesting to note that the director of the school, Prof. A. R. Ling, has been given wide powers for aiding competent research workers concerned with fermentation industries by finding accommodation in his laboratories and in other ways. Applications for such assistance should be made direct to the director of the school.

Societies and Academies.

MANCHESTER.

Literary and Philosophical Society, October 5.—Sir Henry A. Miers, president, in the chair.—Dr. A. E. **Oxley**: Recent researches in magnetism. After dealing briefly with the nature of ferro-magnetism, paramagnetism, and diamagnetism, the author considered the characteristic variations of these properties over a range of temperature varying from that of liquid air to 300° C. Practically all substances show a change of magnetic property when crystallisation takes place, and in the case of certain diamagnetic substances definite hysteresis loops with respect to temperature have been obtained. These loops are similar to those shown by nickel-steels which are ferromagnetic. The experimental results were interpreted in terms of the electron theory of magnetism, and finally extended, through Tyndall's work on the deportment of crystals in a magnetic field, to interpret the nature of crystal structure and the spatial distribution of electrons within the atom. The atomic configuration so deduced is similar to that of the cubical atom developed by Lewis and Langmuir, and distinct from that of the Bohr theory, which fails to account for the magnetic properties. It is considered, however, that these theories may be brought into line in the near future by a due recognition of the possible differences between radiating and non-radiating matter.

PARIS.

Academy of Sciences, September 27.—M. Léon Guignard in the chair.—A. **Appell**: A partial differential equation of the theory of hypergeometric functions.—F. E. **Fournier**: Concerning the apparent displacement of some stars in the total eclipse of the sun of May 29, 1919.—M. **Lugeon** and N. **Oulianoff**: The geology of the Croix-de-Fer massif. The sedimentary zone separating the massif of Mont Blanc from that of the Aiguilles-Rouges has been usually considered as a simple synclinal, but E. Paréjas has recently proved the existence of two synclinals. A study of the region between the Arve and the Trient has now shown that the structure is still more complex, a detailed description of which is given.—C. **Sauvageau**: The indigenous marine algæ capable of furnishing gelose.—V. **Burson**: A solar prominence with great radial velocities. Photographs taken on September 8 showed a prominence visible on the photograph of the lower layer—a phenomenon of great rarity. This was followed up by a series of photographs, and certain parts were shown to have a radial velocity greater than 132 km. per second.—H. **Deslandres**: Remarks on the preceding communication of V. Burson.—J. **Welsch**: Position of the springs on the concave bank of rivers in permeable limestone strata.—R. **Cerighelli**: The gaseous exchanges of the root with the atmosphere. The respiration of plant-roots placed in a confined atmosphere takes place similarly to that occurring with other plant organs; the ratio of carbon dioxide evolved to oxygen absorbed varies between 0·7 and 1·0, according to the species. These results are for detached roots; the modifications caused by contact with a very moist atmosphere and by leaving the plant attached to the roots under experiment are also described.—E. **Rousseaux** and M. **Sirot**: The nitrogenous materials and phosphoric acid during the ripening and germination of wheat.—A. J. **Urbain** and P. **Marty**: The influence of the subterranean work of the mole on the flora of the pasturages of Cantal. The effect of the work of the mole is to drain the soil, to favour the germination and growth of the seeds, and to introduce new plants, often useful.—P. **Wintrebert**: The relations between the aneural ectodermic irritability and the nervous and muscular working in the embryos of Amphibians.—A. **Krempf**: The tentacular apparatus of *Coeloplana gonoctena*.

SYDNEY.

Linnean Society of New South Wales, August 25.—Mr. J. J. Fletcher, president, in the chair.—T. G. **Sloane**: A list of the species of Australian Carabidæ which range beyond Australia and its dependent islands. Forty-four Australian species are recorded from localities outside Australia and its dependent islands as follows:—Africa 1, Amboyna 1, Aru Islands 1, Asia 6, south-east Asia 4, Borneo 1, Burma 1, Celebes 3, Ceylon 5, Egypt 1, India 2, Java 8, Lord Howe Island 2, Malay Archipelago 6, New Caledonia 12, New Guinea 10, New Zealand 3, Siam 1, Sumatra 1, and Sumbawa 3.—T. **Steel**: Dental encrustations and the so-called "gold-plating" of sheep's teeth. For many years past there have appeared from time to time in newspapers and magazines published all over the world statements as to the occurrence of a metallic encrustation on the teeth of sheep. Popularly this encrustation, being frequently of a yellow tint, has been attributed to gold, supposed to have been derived from particles of that metal scattered about the pastures. Complete analyses are given of the encrustation from sheep, ox, man, and a number of other animals, and it is shown to consist of a phosphatic salivary deposit or calculus, and to be common to the teeth of all mammals and of several other animals.—Marjorie I. **Collins**: The structure of the resin-secreting glands in some Australian plants. An account of certain types of glandular hair and of the development of the glands observed during an investigation of the resinous secretion of the bud in seven Australian genera of the natural orders Sapindaceæ, Leguminoseæ (sub-order Mimoseæ), Compositæ, Goodeniaceæ, and Myoporineæ.—Prof. W. N. **Benson**, W. S. **Dun**, and W. R. **Browne**: The geology and petrology of the Great Serpentine Belt of New South Wales. Part ix. The geology, palæontology, and petrography of the Currabubula district, with notes on adjacent regions. (1) More than ninety species are recognised, comprising corals, bryozoa, brachiopods, pelecypods, gastropods, scaphopods, cephalopods, and trilobites, of which five forms previously reported have now been for the first time critically examined, seven are new records for the State, and fifteen species and three varieties are described as new. One new genus of corals is also proposed—a simple turbinate form with a corallum of the Lithostrotion type. (2) A comparison of the Burindi fauna with the Lower Carboniferous faunal succession in the British Isles shows that, on the evidence of thirty-one British species of brachiopods in the Burindi series, it should be placed at the very base of the Viséan series or on the Tournaisian-Viséan boundary. This accords remarkably well with De Koninck's conclusions put forward forty years ago.

Books Received.

An Introduction to the Study of Terra Sigillata: Treated from a Chronological Standpoint. By F. Oswald and T. D. Pryce. Pp. xii+286+lxxxv plates. (London: Longmans, Green and Co.) 42*s.* net.

Feeblemindedness in Children of School-Age. By Dr. C. P. Lapage. Second edition. Pp. xv+309+ plates. (Manchester: University Press; London: Longmans, Green and Co.) 10*s.* 6*d.* net.

A Book about Plants and Trees. By R. and S. G. Gurney. Pp. xvi+103. (London: C. Arthur Pearson, Ltd.) 1*s.* 6*d.* net.

Studies in Contemporary Metaphysics. By R. F. A. Hoernlé. Pp. ix+314. (London: Kegan Paul and Co., Ltd.) 16*s.* net.

Type Ammonites. By S. S. Buckman. Part xxiii. Pp. 19–24+13 plates. (London: W. Wesley and Son.)

Easy Lessons in Einstein. By Dr. E. E. Slosson. Pp. vii+128. (London: G. Routledge and Sons, Ltd.; New York: Harcourt, Brace and Howe.) 5*s.* net.

Psycho-analysis: Its History, Theory, and Practice. By A. Tridon. Pp. xi+272. (London: Kegan Paul and Co., Ltd.) 10*s.* 6*d.* net.

A Naturalist on Lake Victoria. With an Account of Sleeping Sickness and the Tse-tse Fly. By Dr. G. D. Hale Carpenter. Pp. xxiv+333. (London: T. Fisher Unwin, Ltd.) 28*s.* net.

Memoirs of the Geological Survey. Special Reports on the Mineral Resources of Great Britain. Vol. xiii. Iron Ores (continued). Pre-Carboniferous and Carboniferous Bedded Ores of England and Wales. By Sir A. Strahan and others. Pp. iv+123. (London: E. Stanford, Ltd.; Southampton: Ordnance Survey Office.) 7*s.* 6*d.* net.

Smithsonian Institution. United States National Museum. Bulletin 110. Osteology of the Carnivorous Dinosauria in the United States National Museum, with Special Reference to the Genera Antrodemus (Allosaurus) and Ceratosaurus. By C. W. Gilmore. Pp. xi+159+36 plates. (Washington: Government Printing Office.)

The Practice of Railway Surveying and Permanent Way Work. By Prof. S. Wright Perrott and F. E. G. Badger. Pp. viii+303. (London: E. Arnold.) 30*s.* net.

Reinforced Concrete Design. By Dr. O. Faber. Vol. ii., Practice. Pp. xii+246. (London: E. Arnold.) 18*s.* net.

Fisheries—England and Wales. Ministry of Agriculture and Fisheries. Fishery Investigations. Series iii., Hydrography. Vol. i., The English Channel. Part v., The Section from Plymouth to Brest. Pp. 19. (London: H.M. Stationery Office.) 2*s.* net.

Department of Scientific and Industrial Research. British Association for the Advancement of Science. Third Report on Colloid Chemistry and its General and Industrial Applications. Pp. 154. (London: H.M. Stationery Office.) 2*s.* 6*d.* net.

Milk Testing. By C. W. Walker-Tisdale. Second edition. Pp. 90. (London: J. North, 98 Fetter Lane.) 3*s.* 6*d.* net.

Moby-Dick or the Whale. By H. Melville. (The World's Classics.) Pp. xii+675. (London: Oxford University Press.) 2*s.* 6*d.* net.

Opera Hactenus Inedita Rogeri Baconi. Fasc. v. Secretum Secretorum cum Glossis et Notulis. Tractatus Brevis et Utilis ad Declarandum Quedam Obscure Dicta Fratris Rogeri. Nunc Primum Edidit Robert Steele. Accedunt Versio Anglicana ex Arabico Edita per A. S. Fulton. Versio Vetusta Anglo-

Normanica Nunc Primum Edita. Pp. lxiv+317. (Oxonii: E. Typographeo Clarendoniano.) 28s. net.

Rudiments of Electrical Engineering. By P. Kemp. Pp. viii+255. (London: Macmillan and Co., Ltd.) 6s.

The Ila-Speaking Peoples of Northern Rhodesia. By the Rev. E. W. Smith and Capt. A. M. Dale. Vol. i., pp. xxvii+423; vol. ii., pp. xiv+433. (London: Macmillan and Co., Ltd.) Two vols., 50s. net.

The Early History of Surgery in Great Britain: Its Organisation and Development. By Dr. G. Parker. (Medical History Manuals.) Pp. ix+204. (London: A. and C. Black, Ltd.) 7s. 6d. net.

Elementary Dynamics: A Text-book for Engineers. By J. W. Landon. Pp. viii+246. (Cambridge: At the University Press.) 10s. 6d. net.

Memoirs of the Geological Survey. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for 1919. Pp. 70. (London: E. Stanford, Ltd.) 2s. 6d. net.

Companions: Feathered, Furred, and Scaled. By C. H. Donald. Pp. ix+159. (London: John Lane; New York: The John Lane Co.) 7s. net.

Essentials of Physiology. By Prof. F. A. Bainbridge and Prof. J. A. Menzies. Fourth edition. Pp. viii+497. (London: Longmans, Green and Co.) 14s. net.

Diary of Societies.

THURSDAY, OCTOBER 21.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Squad.-Ldr. R. M. Hill: A Comparison of the Flying Qualities of Single- and Twin-engined Aeroplanes.—C. Baker: Night Flying.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), Special General Meeting, at 5.30; at 5.45.—J. Morrow Campbell: The Origin of Primary Ore Deposits.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. A. R. Abelson: A Psychological Study of the Delinquent Child.

FRIDAY, OCTOBER 22.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Keith: Demonstration on the Contents of the Museum.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 5.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Capt. H. Riall Sankey: Presidential Address.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—F. Martin-Duncan: Birds and Beasts from many Lands.

JUNIOR INSTITUTION OF ENGINEERS (at Caxton Hall), at 8.—A. H. Fitt: Impulse Turbines.

ROYAL SOCIETY OF TROPICAL MEDICINE (at 11 Chandos Street, W.1), at 8.30.—Prof. W. Yorke: The Present Position of Trypanosomiasis Research.

MONDAY, OCTOBER 25.

FARADAY SOCIETY AND PHYSICAL SOCIETY OF LONDON (at Institution of Mechanical Engineers), at 2.30.—Joint Discussion on The Physics and Chemistry of Colloids and their Bearing on Industrial Questions. Prof. The Svedberg: A Short Survey of the Physics and Chemistry of Colloids.—Discussion on Emulsions and Emulsification. Opener: Prof. F. G. Donnan.—W. Clayton: Emulsion Problems in Margarine Manufacture.—S. S. Bhatnagar: Reversal of Phases in Emulsions and Precipitation of Suspensoids by Electrolysis: an Analogy.—Discussion on Physical Properties of Elastic Gels. Openers: E. Hatschek and Prof. H. R. Procter.—S. C. Bradford: The Reversible Sol-gel Transformation.—Dr. J. O. W. Barratt: The Structure of Gels.—Discussion on Glass and Pyrosols. Opener: Sir Herbert Jackson.—Discussion on Non-Aqueous Systems. (a) *Nitrocellulose*. Opener: Sir Robert Robertson.—F. Sproxton: Non-Aqueous Colloid Systems with Special Reference to Nitrocellulose.—Dr. G. Barr and L. L. Bircumshaw: The Viscosity of Some Cellulose Acetate Solutions. (b) *Rubber*. Opener: B. D. Porritt: The Action of Light on Rubber.—Discussion on Precipitation in Disperse Systems. Openers: Dr. R. C. Tolman and Dr. R. S. Willows.—J. N. Mukherjee: The Origin of the Charge of a Colloidal Particle and its Neutralisation by Electrolytes.—W. Clayton: Coagulation of Inorganic Suspensions by Emulsions.—Discussion on Cataphoresis and Electro-endosmose. Opener: Prof. A. W. Porter.—Dr. W. Ormandy: Some Practical Applications of Electro-endosmose and Cataphoresis.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. S. G. Shattock: Demonstration of Pathological Specimens in the Museum.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—W. H. Dolamore: The Importance of Clinical Observation in Dental Surgery (Presidential Address).

MEDICAL SOCIETY OF LONDON, at 8.30.—Prof. J. B. Leathes and others: Discussion on The Determination of Degree of Renal Function.

TUESDAY, OCTOBER 26.

SOCIOLOGICAL SOCIETY (at 65 Belgrave Road), at 5.15.—H. Carter and R. Unwin: Impressions of the New Germany.

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.30.—Dr. F. Parkes Weber: The Differentiation of the Secondary Forms of Polycythæmia Rubra.—Dr. Paterson: Notes on a Case of Transient Polycythæmia in a Child.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Rev. R. A. Lorrain: The Wild Head-hunting Tribes of Lakherland: their Manners and Customs.

WEDNESDAY, OCTOBER 27.

INSTITUTE OF AERONAUTICAL ENGINEERS (at Royal College of Science), at 7.45.—Col. N. T. Belaiew: The Structure of Steel.

THURSDAY, OCTOBER 28.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Dr. M. O. Forster: The Emil Fischer Memorial Lecture.

ABERNETHIAN SOCIETY (at St. Bartholomew's Hospital), at 8.30.—Sir St. Clair Thomson: Recollections of Joseph Lister by one of his House-surgeons.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Sir Thomas Horder: The Treatment of Sub-acute Nephritis by Decapsulation; with an Account of Four Cases.—W. Bonney: A New Operation for Nephroptosis.

FRIDAY, OCTOBER 29.

ROYAL GEOGRAPHICAL SOCIETY (at the Æolian Hall), at 5.—T. A. Barns: In the Land of the Okapi and the Gorilla.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Keith: Demonstration on the Contents of the Museum.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. W. Bennett: Winchester: The Cathedral, the School, and the Hospital of St. Cross.

CHEMICAL INDUSTRY CLUB (at 2 Whitehall Court), at 8.—Annual Meeting.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.30.—Dr A. K. Chalmers: The Function of the Isolation Hospital in a General Scheme of Hospital Provision.

CONTENTS.

NATURE

THURSDAY, OCTOBER 28, 1920.

Editorial and Publishing Offices:
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Museums in Education.

FOR many years past a number of people, approaching the question from diverse or even opposite sides, have agreed that our museums should do more for education, and that our educational establishments should be brought into closer touch with museums. The desire for mutual aid is expressed by representatives of science, art, classical studies, history, and industry. A discussion of the subject in the Education Section of the British Association at Birmingham in 1913 led to the appointment of a committee drawn from many sections "to examine, inquire into, and report on the character, work, and maintenance of museums, with a view to their organisation and development as institutions for education and research, and especially to inquire into the requirements of schools." A wide reference—and the committee, composed of university officers and professors, school inspectors and teachers, humanists and men of science, administrators and museum curators, has taken a wide sweep and a broad view. The final report, now before us,[1] was deferred owing to the difficulties and economies of wartime, and is now published with the forced omission of the detailed data on which the conclusions are based. This, however, makes it the easier reading, and read it should be by all interested in either museums or education.

Those who are to be educated by museums may be classed as the general public, the pupils of primary and secondary schools, students at universities and similar institutions, and, finally, postgraduate and other advanced students. In the past the attempt to reach these people has been subject to many difficulties. The name "museum" has diverse connotations; while some museums, of modern origin, are purely educational in aim, those of older foundation were not, and cannot be, primarily engines of education. None the less, the officials of the latter have long been anxious to enlarge this side of their work. The appeal to the general public, initiated by Flower in the Natural History Museum, has been followed and surpassed elsewhere, notably in the United States. With us the provision of guide-books and of the human guides so strenuously advocated by Lord Sudeley demands more money than is forthcoming. But the real difficulty in our larger museums has always been the conflicting aims of the exhibition galleries. This will not be overcome until the reference series for collectors and advanced students are separated from the more popular and elementary exhibits, just as the research collections are already separated. Above all, in every museum there is the difficulty of the overworked and underpaid curator.

Turning to the other side, we have found difficulties in the schools. The value of the museum and of museum material has not been appreciated by teachers. It was too much trouble. "When the ground is covered by manuals, why try to drag in pictures or objects which are a bother to look after, and which distract the pupil's attention from his book? And, as for taking the class to a museum, how are we to find either time or money?" Our great public schools have some excellent museums, but there is little or no evidence that they are used in school teaching. Our universities have museums, or collections specially designed for their students, but too often they compete rather than co-operate with the public museums of their neighbourhood. As for industries, they keep their own secrets, and (except in a few instances, as the Potteries museum) do not realise the value of museums for their purposes. Possibly curators, too, have not always realised the service they themselves might render to industry.

In these matters, as in so much else, the war has produced a change of conditions and a change of view. Museums have proved their usefulness

[1] British Association, Section L (Cardiff, 1920). "Museums in Relation to Education." Final Report of Committee (Prof. J. A. Green, chairman; Mr. H. Bolton and Dr. J. A. Clubb, secretaries; Dr. F. A. Bather, Rev. H. Browne, Mr. C. A. Buckmaster, Prof. E. J. Garwood, Dr. A. C. Haddon, Dr. H. S. Harrison, Mr. M. D. Hill, Dr. W. E. Hoyle, Sir H. Miers, Prof. P. Newberry, Mr. H. R. Rathbone, Dr. W. M. Tattersall, Sir Richard Temple, Mr. H. Hamshaw Thomas, Prof. F. E. Weiss, and Dr. Jessie White). Pp. 14. Price, post free, 6*d*. Six or more copies at 2*d*. each.

to the State; the public has protested in surprising fashion its affection for museums. Recent legislation has recognised this in removing the rate-limit for municipal museums, and in facilitating the promotion of museums by the education authorities of the counties and boroughs. The committee, though it welcomes this change of attitude, does not do so without warning and criticism. It recognises that municipal and national museums are not the only kinds deserving of State- or rate-aid; there are semi-private museums which need it even more. It is a little afraid of control by an "authority" that may know all about education, but certainly knows little about the governance, organisation, and financial needs of museums; and it would like to see "some national or central authority fully conversant" with such matters, to whom local museum committees might turn for advice—or perhaps something still more satisfying. Such welcome as the committee does give to the education authority seems due to its hope that the education grant will pay for the extra material and the special staff required for such desirable works as loan collections for schools or school classes in the museum. It also suggests that recent legislation may find its best fruits in establishing museums in towns as yet unprovided with them.

It is rather striking that, of the five general conclusions emphasised by the committee, the first four have reference to research. In research the universities should co-operate. To aid research, lists of contents should be published. Grants in aid should be proportioned to the research conducted by a museum, no less than to its other activities. Curators must have had a university training, fitting them for research as well as for administration. All this may not seem to have much to do with education. But the committee is right. Granted that the collection and preservation of material objects constitute the *differentia* of a museum, it is clear that the first necessity is the study of those objects. "This research must be prosecuted if museums are to fulfil their highest function, which is the advancement of Science, Art, and Industry." Research is a necessary preliminary to any and every other function of a museum, and not least to the function of education. We cannot deal here with the many practical recommendations scattered through the body of the report, and perhaps not sufficiently distinguished by type or spacing from their context. They should prove acceptable and useful to both educationists and museum officials. We would, however, reiterate our high appreciation of the committee's labours and of the firm stand that it takes on the really fundamental principles.

The chief conclusion we would ourselves draw from this report is that there is a vast body of experience relating to the proper management of museums and their use in education, and not in that alone. Much of it forms the basis of this report; much is to be found in the publications of the Museums Association and in a few books that have been published. But the local authority faced with the task of founding a museum, or of taking over and utilising one already in existence, knows nothing of all this. On this ground, then, but not on this alone, we warmly approve the suggestion that there should be a central council or board, composed of persons with knowledge and sympathy, and endowed with the requisite powers, to watch over and aid the inception of museums, to co-ordinate their work when established, and to bring them into touch with the national museums. Such a council as we have in view would certainly not wish all museums to conform to one pattern or to rigid rules, but it might save much duplication of work and expenditure and much ill-directed effort.

Scientific Methods of Design and Control in Chemical Industry.

Ministry of Munitions. Department of Explosives Supply: Preliminary Studies for H.M. Factory, Gretna, and Study for an Installation of Phosgene Manufacture. Pp. xvi+145. (London: H.M.S.O., n.d.) Price 15*s*. net.

DURING the war an enormous amount of work was done by the Department of Explosives Supply in the design of chemical plant, processes, and works, and in the construction, organisation, and control of the numerous national and other factories dealing with the manufacture of explosives and closely related substances. Lord Moulton, who was Director-General of Explosives Supply, and whose magnificent work in the cause of Great Britain and the Allies cannot be overestimated, was fortunate in having associated with him a devoted band of men of exceptional ability and knowledge. Pre-eminent amongst these on the technical and scientific side was Mr. Kenneth B. Quinan, who was responsible for the design, construction, and organisation of the works controlled by the Factories Branch. Where all worked so splendidly, it might seem invidious to single out one name. But the writer well knows that amongst the hundreds, or indeed thousands, of men who fought the war behind the front so splendidly in the Department of Explosives Supply there is not one who did not look up to "K. B. Q." as the great inspirer and organiser, or who failed to realise what the nation owed to his genius, personality, and indefatigable labour.

Mr. Quinan was also a great educator. One cannot explain this better than by quoting from the excellent preface to the present book.

"Mr. Quinan introduced methods of studying the various problems which arose and setting out the results, which were clear and very helpful to all who were connected with the erection of the plant and works, or the subsequent manufactures carried out. . . . Mr. Quinan insisted that the steps in a calculation by which certain results were obtained should be set forth so distinctly that they could easily be followed, and that the author himself might be able to trace the line of his reasoning and action after the matter had passed from his attention, without having to rack his brains to see how he had obtained his results. He thoroughly believed in the advantage of letting all those who were engaged in directing and carrying out work have the fullest possible understanding of what they were doing, and this policy bore excellent fruit in the results obtained at the works managed by the Factories Branch, which were carried on under the initial disadvantage of staff and workers largely without expert knowledge of the work they had to do."

In pursuance of this policy, every working drawing was accompanied by a well-reasoned description of the purpose and function of the various parts of the apparatus or plant, and the technical staffs at the various factories were constantly engaged, at Mr. Quinan's instigation, in studying the working of their plant, carrying out laboratory and plant researches, and vying with each other in a continuous process of improvement in the efficiency of the plant and in their understanding of the scientific principles underlying its design and operation.

It can well be imagined that, as a result of these methods, Mr. Quinan accumulated a vast amount of material, scientific and technical, of the greatest value to the nation, and especially to the young men who are destined to become the technical workers and the leaders of the next generation. It was Mr. Quinan's earnest wish that as much as possible of this material should be edited and published after the war for the benefit of the scientific institutions of the country and for all those young men who are already engaged in the chemical industries of the British Empire. It is extremely fortunate for the successful execution of this great work that the Government has entrusted it to Mr. William Macnab, who was a member of the Department of Explosives Supply throughout its whole existence (and of the original Committee of the War Office from which the Department sprang), and very closely connected with its development and with every phase of Mr. Quinan's work.

The present volume is published under the *aegis* of the Ministry of Munitions, but the continuation of the work has been entrusted to the Department of Scientific and Industrial Research, which will publish a number of other volumes. It would be impossible to exaggerate the national importance of this work. To apply scientific principles and data to the development of industrial plant and processes requires just as much scientific method, research, and intellectual labour as the discovery of the general principles and data of science. A failure to realise this, an all-too-narrow interpretation of the words "science" and "research," accounted for many errors in the past and for much of our unpreparedness when the stress of war came so swiftly upon us. There was, however, another factor, and one of cardinal importance. There existed few, if any, examples, accessible to all, and drawn from real practice, of the methods employed by the great scientific designers and creators of industry. How does one design a plant, a process, or a works? Who was there to answer that question? How did the Glovers, Deacons, Hurters, and Monds—to mention only a few great names drawn from chemical industry—set about their work? There were plenty of books on chemical technology, but not a word on the real thing, the method of research, the way to go about it. It is a supremely difficult thing to apply science scientifically and successfully. You are not free to choose your variables, or to eliminate unpleasant ones. The whole universe is on the top of you. You cannot say that you are a chemist and, therefore, do not intend to worry about the physical and engineering aspects of the problem. Unfortunately, a chemical plant is a bit of Nature, and includes, therefore, all the sciences. And Nature is not particularly concerned with the limitations of one's education or one's particular tastes and temperament. It is no doubt perfectly true that a man can learn to be a real technical chemist only by long practical experience in works. But it is of the greatest importance for the training of young men in the later stages of their work at the universities and higher technical schools that those whose capacities and temperaments incline them to industrial work should have the possibility of studying some first-class examples of how scientific principles and data are utilised and developed in the creation of processes and plant.

For the first time in the history of chemical science this is made possible by the publication of these volumes. A close study of this and the succeeding volumes will show the young chemist how physics, physical chemistry, and engineering must be combined with exact chemical knowledge. He will find here large numbers of drawings in plan and elevation which he can utilise in his study of engineering drawing as applied to chemical plant. He will see how, step by step, leaving nothing to chance, the elaborate calculations are carried out whereby from a number of fundamental data the complete flow-sheets and precise working details of large chemical factories are quantitatively developed. He will learn how every technical chemical problem involves much knowledge of physics and engineering, and he will see how much the practical chemical designer has to do with questions of heat absorption and evolution, and the transfer and transmission of heat. Most important of all, he will learn that the object of the truly scientific designer is to guess at nothing, but, if possible, to reduce everything to fundamental principles, precise quantitative data, and systematic calculation.

In the present volume the larger part—*i.e.* that relating to the design of the great Gretna works for the production of cordite and nitroglycerine—presents to the student of chemical industry and chemical engineering a unique object for study. The plan adopted by Mr. Macnab is to set forth systematically all the calculations as to quantities and capacities to be dealt with by the various sections of the plant and works. These calculations are summarised in a complete series of flow-sheets. The various sections and the general lay-out are illustrated by a large number of engineering drawings, all of which are accompanied by detailed descriptions which add enormously to their value. The "Study for an Installation of Phosgene Manufacture" is a fine piece of work, and an excellent example of Mr. Quinan's method of utilising thermo-chemical and physical data in the solution of a technical chemical problem. This "study" is a little classic, and will undoubtedly prove a source of inspiration and instruction of the very highest value. The student can here see for himself how, given certain chemical and physical data, the trained and experienced chemical designer sets to work to decide between the claims of rival processes and to develop the technical details of the selected one.

Mr. Macnab is warmly to be congratulated on the splendid way he has carried out his work. The intellectual and manual labour involved must have been very great, but they are justified by the excellence of the result. It can be stated with certainty that the present volume and its successors will constitute a handbook of applied chemical and physical science without its equal in any language. The effects as regards the scientific training of the new generation of chemical students will be far-reaching. The Explosives Supply Department had to produce in gigantic measure the chemical weapons of destruction. In these volumes the work of the Department will live for many years to come as a great and noble contribution to the edifice of reconstruction. It is earnestly to be hoped that the Government Departments now concerned will realise the vast importance of this undertaking and so publish ample editions of the various volumes. There exists here a splendid opportunity of extracting good from the terrible waste of war, and of sowing seed which will produce a rich harvest in the years to come.

One cannot put this volume down without thinking of the great days when Mr. Quinan worked at Storey's Gate. The unique professional knowledge derived from many years of technical experience, the unremitting work of a powerful and vigorous mind, and the irradiating influence of a great, genial, and unselfish personality were unreservedly put at the disposal of the British Empire. An atmosphere of good fellowship and of equal comradeship in work pervaded every branch. Everyone who came under the influence of Mr. Quinan was stimulated to put forth his best in the general cause.

These volumes will constitute an enduring memorial to the work of one of America's greatest sons, a man who did as much as anyone to win the Great War, and in doing so won the respect and affection of all who knew him.

F. G. DONNAN.

Experimental Science in India.

The Life and Work of Sir Jagadis C. Bose: An Indian Pioneer of Science. By Prof. Patrick Geddes. Pp. xii + 259. (London: Longmans, Green, and Co., 1920.) Price 16*s.* net.

THE author of this biography was fortunate in his subject: it was no hard task to write an interesting chronicle of so eventful a life and of so striking a personality. Sir J. C. Bose is equally fortunate in his biographer: his life and work are set forth with conspicuous literary skill, scientific knowledge, and sympathy with the East. The result is a singularly instructive and eminently readable book.

The story of his life shows that Sir J. C. Bose had to contend, at all stages, with difficulties of every kind. The first and most fateful was that of securing a university education in England. It is narrated how this difficulty was overcome, so that in 1881, at the age of 23, he was able to enter the University of Cambridge as a scholar of Christ's College, the college of which his brother-in-law, Mr. A. M. Bose, the first Indian wrangler, had become a member ten years previously. It may be incidentally mentioned here that Mr. Fitzpatrick, who is mentioned as one of his college friends (p. 29), is not, as stated, Master of Emmanuel College, but President of Queens' College. Having successfully completed his university career, Bose returned to India to face the next serious difficulty—that of obtaining a suitable educational post. It is explained how impossible it seemed to the official mind that a native of India should be fitted by ability and attainments for a professorship in physical science—there was no precedent for such a claim! However, chiefly by the influence of the then Viceroy, Lord Ripon, Bose was appointed professor of physics in the Presidency College, Calcutta, a post which he held until 1915. During this period he was busily engaged, not only in maintaining and increasing the efficiency of his department by securing adequate laboratory accommodation, but also in carrying on the researches that have made his name famous.

Of these researches the author gives an attractively lucid and succinct account. The first were wholly physical, and to these three chapters (iv.-vi.) are devoted. Their main subject was that of the properties of the Hertzian electric waves, by which wireless telegraphy is effected. It is of interest to note that, so far back as 1895, Bose had demonstrated the passage of these waves from one part to another of his laboratory building. In the course of this work he observed that his metallic receivers manifested signs of "fatigue," an observation which led him to a comparison, in this respect, of metals and of animal- and plant-tissues, with the result that he found them to be essentially identical (chap. vii., "Response in Living and Non-Living"). He became so deeply interested in the study of the irritability and movements of plants that for the next twenty years he devoted himself almost exclusively to it. An adequate account of his remarkable work in this direction is given in chaps. ix.-xv. The results may be summed up in the brief statement that the phenomena of irritability of animals and plants are altogether analogous, and that the multiform movements of plants are susceptible of a simple universal explanation, depending fundamentally on the quantity of stimulus received. These great generalisations were rendered possible by the employment of recording apparatus much more delicate than any previously devised, and capable of magnifying the minute movements a thousand or even a million times. The last, and the most formidable, of the difficulties to be overcome was that of securing recognition of his work. So long as Bose's researches were confined to purely physical subjects it did not arise; but when he trespassed into the domain of physiology opposition became strong in this country, though on the Continent and in America his results were received with enthusiasm. Here the antiquated idea of "water-tight compartments" in science asserted itself to such an extent that it was not for many years that justice was done. All this is fully discussed in the author's pages, where it is also made clear that ultimate triumph was due not to ability alone, but mainly to strength of character and lofty ideals.

The sub-title of the book is "An Indian Pioneer of Science." Like all pioneers, Sir J. C. Bose has had to encounter many and great difficulties and, as has been pointed out, he has, unlike many pioneers, successfully overcome them. It is to be hoped that, now that the days of storm and stress are over, he may be able to devote all his energy to the continuance of his work in the Institute that he has founded for the purpose. The volume is well got up, and is illustrated with portraits and many figures of apparatus and records. It would have been an advantage if a full bibliography of Sir J. C. Bose's works had been appended, while the index would be more useful if it were more complete.

Elementary Geometry.

Practical Geometry. By C. Godfrey and A. W. Siddons. Pp. xv+256. *Theoretical Geometry: A Sequel to "Practical Geometry."* By C. Godfrey and A. W. Siddons. Pp. xiv+104. (Cambridge: At the University Press, 1920.) Price 7s. net. (Complete in one volume.)

THE authors of these two volumes (obtainable also as a single book) regard the teaching of geometry as divisible into four stages. The first consists of little more than instruction in the use of instruments and methods of measurement, including drawing to scale. The second is an intuitive treatment of a few fundamental propositions, and merges into the third stage, which covers the whole field of the ordinary course of elementary geometry, plane and solid, treating the various theorems in an informal fashion, and explaining the methods of constructions, often without proof, in the natural order suggested by the theorems. In these stages the pupil is led to apply the results of the theorems, whether formally proved or not, both to numerical examples and to formal riders. The fourth stage knits all the theorems, previously considered, into a logical chain with formal proof. A few riders are interspersed, and there is a considerable amount of general discussion in this part of the text; the section closes with a collection of riders arranged under headings corresponding to suitable groups of propositions.

With the general changes of procedure adopted by the authors we are in entire agreement. There can be no question that boys are capable of making simple applications of the fundamental theorems of geometry long before they are able to appreciate the formal proofs, and the stimulus which work of this nature supplies is most beneficial to their mental development.

On its numerical side the exercises are very good, being numerous, varied, and interesting; on the formal side we do not consider the work quite so satisfactory; more riders of the "two-step" nature are needed, particularly, for example, in dealing with angle and tangent properties of the circle. We think also that much of the discussion, which at present bulks so largely in the text, might be omitted. We doubt whether any boy reads it, and there is much that we find hard to believe is really necessary for the instruction of the teacher at the present time, when modern methods are so much better understood than they were, say, fifteen years ago. Some drastic pruning of this kind would affect materially the size of the book, and, we think, leave its utility unimpaired, and at the same time appear to lighten the student's burden.

The printing is excellent, and the diagrams are clear and numerous. A set of answers and suggestions for class-work (which we have not seen) is issued separately. We regard the new form of this text-book as a definite advance in the right direction, and commend it to teachers.

The Evolution of Vertebrate Animals.

Die Stämme der Wirbeltiere. By Prof. Othenio Abel. Pp. xviii+914. (Berlin and Leipzig: Walter de Gruyter and Co., 1919.) Price 56 marks.

PROF. ABEL, of Vienna, is a most voluminous writer on extinct animals, and even the difficult circumstances of the time do not impair his energy and enthusiasm. He has now produced a most interesting volume summarising our present knowledge of the past history of the backboned animals, and his technical descriptions are illustrated by numerous up-to-date figures which are refreshing by their newness in a text-book. The work is not merely a laborious compendium, but is enlivened by many critical observations based on Prof. Abel's own researches.

Prof. Abel's classification will not in all respects prove acceptable. He avoids too many difficulties in the determination of affinities by an undue multiplication of sub-classes and orders. He also in some cases adopts the fantastic proposals of certain dabblers in scientific literature who discuss merely names without any acquaintance with the fossils to which they refer. The familiar generic name Ichthyosaurus, for example, completely disappears, while the almost equally well-known name Megalichthys is applied to the wrong fish. The work, however, is intended for advanced students who will be able to make allowance for these idiosyncrasies without much trouble.

According to Prof. Abel, the Cyclostomes are unknown among fossils, because the problematical Devonian Palæospondylus, with its suctorial mouth, is most likely the larval condition of Coccosteus. The earliest fishes are the Upper Silurian Anaspida. The earliest land-vertebrates, the Stegocephala, are treated at great length on account of the primitive character of the skeleton and its morphological importance. Among reptiles, the newly discovered Chelonia, from the Upper Trias of Germany, are especially striking. Some of them retain traces of true teeth. The Dicynodonts are described as "the Sirenians among reptiles." The Triassic Parasuchia and Pseudosuchia are separated from the Crocodilia. The marine Thalattosauria, from the Trias of California, are arranged with the Lacertilia. The birds are treated in the usual manner.

Among mammals, the Monotremata are regarded as unknown by fossils before the Pleistocene; and the Triassic Tritylodon is referred to the Marsupialia. The South American Tertiary Sparassodonta are also retained among Marsupialia. A few of the mammalian jaws of Jurassic age (*e.g.* Amphitherium and Stylodon) are regarded as belonging to Placentalia. The Insectivora follow, and the Primates, as usual, conclude the series of orders. The various groups are rather unequally treated, but students will be glad to have the preponderating sections on Cetacea and Sirenia as summarising Prof. Abel's own researches.

The volume is provided with two exhaustive indexes, one to morphology, the other to taxonomy, and is a most valuable work of reference, which should be added to every zoological library.

A. S. W.

Essays in Social Psychology.

(1) *Instincts of the Herd in Peace and War.* By W. Trotter. Second edition. Pp. 264. (London: T. Fisher Unwin, Ltd., 1919.) Price 8s. 6d. net.

(2) *The Century of Hope: A Sketch of Western Progress from 1815 to the Great War.* By F. S. Marvin. Second edition. Pp. vii + 358. (Oxford: At the Clarendon Press, 1919.) Price 6s. net.

(1) DR. TROTTER has not changed anything to speak of in the body of his remarkable book, which was published in 1916, but he has added a postscript of much interest. It deals first with the discouraging fact that "in a belligerent country all opinion in any way connected with the war is subject to prejudice, either pro-national or anti-national, and is very likely in consequence to be of impaired validity." The manifestations of the herd-instinct in the German people were in accordance with the type to be seen in the predaceous social animals; the manifestations of the same instinct in the British people were of the socialised type of gregarious animal—"possessing the power of evolving under pressure a common purpose of great stability." Societies in the past have failed in stability and full functional effectiveness; these defects have been due to "the drift of power into the hands of the stable-minded class, and to the derivation of moral power and enterprise from the mechanisms of leadership and class segregation." To avoid this there must be a continually progressive absorption of the individual members of the society into the general body—a movement towards a complete moral homogeneity and integration. "The only way in which society can be made safe from disruption or decay is by the intervention of the conscious and instructed intellect as a factor among the forces ruling its development." But the unanswerable question is whether the purposive foresight of the intellect will be able, more effectively than in the past, to free itself from instinctive inhibitions.

(2) Mr. Marvin has added to his stimulating book a time-chart of developments in "thought" and "action"—or culture and politics—in the last century, and he has made a number of improvements in the body of the text. On the general thesis he stands to his guns. The hopefulness of the last century has not been exhausted; on the contrary, the sources of hope are unimpaired. In mechanical science and invention, biology and hygiene, psychology and education, sociology and statecraft, literature and religion, and in other lines of development, there have been advances in the past century which seem on the whole to have made for the fuller realisation of the higher values which the racial consciousness at its best has always cherished. What Mr. Marvin's book shows, it seems to us convincingly, is that the momentum continues in a progressive direction. There is no doubt much to discourage, but all the departments of higher human activity are full of live seeds of good pedigree, and in their promise there is progress.

Our Bookshelf.

The Assessment of Physical Fitness: By Correlation of Vital Capacity and Certain Measurements of the Body. (With Tables.) By Prof. Georges Dreyer, in collaboration with George Fulford Hanson. Pp. xi + 115. (London: Cassell and Co., Ltd., 1920.) Price 10s. net.

ALTHOUGH various observers had made attempts to measure the respiratory capacity of the human body, the real pioneer work in spirometry was done about eighty years ago by John Hutchinson. Hutchinson worked out the vital capacity in relation to height, body weight, chest circumference, and age, attaching most importance to the first. He also made many observations as to the effect of disease upon the vital capacity, especially as regards phthisis. After the publication of his method of spirometry, considerable discussion arose both in this country and on the Continent as to its value in clinical medicine. By some clinicians it was held that the normal variations of health were so great as to preclude its extended use. The value of Hutchinson's figures in regard to height were early called in question, either as being too large or not of so great a value as figures calculated from the trunk length or sitting height. In the main, the results obtained by various observers were in favour of Hutchinson. In the little monograph by Prof. Dreyer and his colleague extensive tables are published showing the relationship of the vital capacity to sitting height, weight, and chest circumference. As Dr. F. S. Hobson has shown (NATURE, August 26), these tables will be of particular value to all those who are in any way interested in correlating the vital capacity with physical fitness. It is of interest that Prof. Dreyer and his co-workers have drawn conclusions contrary to those of Hutchinson in regard to the value of the sitting height, and also that age is looked upon as a factor of little or no importance up to about fifty years.

Handbook of Patent Law of All Countries. By W. P. Thompson. Eighteenth edition, completely revised. Pp. vii + 157. (London: Stevens and Sons, Ltd., 1920.) Price 6s.

THE assistance that such a book as this must give to inventors and patent agents fully justifies the issue of a new edition brought up to date with respect to British and foreign patent law and practice. The foreign section is very comprehensive —Bechuanaland and Eritrea, both of which have, we believe, issued Patent Ordinances, are the only countries we miss—though it would have been convenient if information had been given of the method of making an application in some of the smaller States that have no separate Patent Office. A very useful feature is the information given indicating the countries in which inventions relating to particular subjects should be patented. This might well be amplified in a later edition, especially with reference to the smaller States. Mr. Thompson does not refer to Luxembourg's withdrawal from the German Customs Union in December, 1918, but this is important, since, in consequence, patents granted there will presumably no longer be dependent on the corresponding patents taken out in Germany. Rumania, too, should have been included amongst those adhering to the International Convention. The British law is very well presented, though we have noticed a few errors in the statutory time limits allowed for accepting and sealing specifications. The statement on p. 14 that unless a complete specification is accepted within the statutory period it becomes public property is obviously an oversight, as such a specification is not published and remains secret. The book, however, is generally accurate, and should prove a very valuable and trustworthy guide to would-be patentees.

The Statesman's Year Book. Statistical and Historical Annual of the States of the World for 1920. Edited by Sir J. Scott Keltie and Dr. M. Epstein. Fifty-seventh annual publication. Pp. xliv+1494. (London: Macmillan and Co., Ltd., 1920.) Price 20*s*. net.

THE authors of this ever-welcome annual have conquered many difficulties in their survey of the world as it appeared in May, 1920. The maps indicate the new boundaries of South-eastern Europe and the Near East, and the new divisions of the former German colonies Togo, Kamerun, and German East Africa. In the text, however, the partitions of these ex-German territories has not been worked out. The difficulties of compilation are illustrated by the treatment of Czecho-Slovakia and Yugo-Slavia. In the first case an attempt has been made to bring together the statistics relative to the former Austrian and the former Hungarian lands, while in the second instance full details are given for Serbia only.

Mining statistics for Germany chiefly refer to 1913; there is no estimate of the probable yield of the new Germany. Hungary is incorrectly stated to have a common boundary with Germany; statistics for Croatia and Slavonia are included under Hungary, although a paragraph, which might be missed, correctly says that this area forms part of Yugo-Slavia. The list of Hungarian towns is apt to be misleading, since Arad and Temesvar have been omitted, as they are correctly included among the Rumanian towns, while Kolozsvar (Cluj), Nagyszeben (Sibiu), and Brasso (Brasov) appear in both lists. In the case of Spitsbergen it is not clearly stated that the non-Norwegian estates in Spitsbergen are not included under the sovereignty of Norway, but are extra-territorial.

These points indicate the necessarily tentative character of much of this new information. The bulk of the volume maintains the high standard of previous issues.

The Extra Pharmacopoeia of Martindale and Westcott. Revised by Dr. W. Harrison Martindale and Dr. W. Wynn Westcott. Seventeenth edition. (In two volumes.) Vol. i., pp. xxxix+1115. (London: H. K. Lewis and Co., Ltd., 1920.) Price 27*s*. net.

OFFICIAL pharmacopœias are necessarily restricted in their scope, and there are many drugs and other articles used in medicine which for good reasons find no place in them. Hence there is a recognised need for such supplementary books as the "Extra Pharmacopœia," which deal more freely than the official works do with medicinal preparations, appliances, new methods, and so forth. The fact that Martindale and Westcott's work has reached a seventeenth edition is sufficient indication that it meets a want. The single volume of the earlier editions developed into two volumes some years ago, and the most important of these (vol. i.) has become somewhat more bulky than of yore; but it can still be slipped into an overcoat pocket, in spite of its 1154 pages.

A great deal of new matter has been included in this vol. i., the requisite space having been provided in part by transferring the sections on iontophoresis, radium, thorium, and radiology to the second volume (not yet published). Among the sections which have been revised special mention may be made of those on vaccines, antitoxins, colloidal metals, and organotherapy; whilst many useful notes, particularly on the treatment of wounds, have been added to the therapeutic index of diseases. Both the medical practitioner and the pharmacist will find the volume replete with information.

White Lead: its Use in Paint. By Dr. A. H. Sabin. Pp. ix+133. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) Price 7*s*. 6*d*. net.

THE information conveyed in this book is usually of a superficial character. Thus, although processes of manufacture are described, no details are given, and in the descriptions of the application of white lead in paints nothing very new comes to light. The author tells us that "it is not probable that one-thousandth of one per cent. of white lead used in paint is ever discoloured by sulphur, so it is not worth talking about." Unfortunately, however, he gives no alternative explanation of a well-known phenomenon. A similar off-hand style runs throughout the book, and cannot fail to diminish its value.

American Civil Engineers' Handbook. Editor-in-chief, Mansfield Merriman. Fourth edition, thoroughly revised and enlarged. Pp. 1955. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) Price 35s. net.

THE seventeen sections into which the volume is divided cover the whole field of civil engineering, together with mathematical tables, mechanics, physics, meteorology, and weights and measures. The fact that there is but little overlapping indicates that the work of the editor-in-chief has been done thoroughly. Books of this kind must contain the information in a condensed form; in the present volume, however, the condensation has not been carried to the extent which sometimes obtains, making the contents a mere dictionary. On the contrary, each of the sections is presented in a readable form, and is profusely illustrated. British practice differs in many respects from American, but there is much in common, and so much of value in the latter as to make it almost essential for students of civil engineering to have some knowledge of American practice. In no other single book that we have seen can so much information be obtained regarding the practice of civil engineering in the United States, and we can confidently recommend the book as a useful addition to the British civil engineer's library.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The British Association.

WE must first tender you our best thanks for having, at this time of inevitable reconstruction, opened your columns to a discussion which has been of great value in showing the general trend of opinion concerning the future of the British Association. We have had the benefit of letters from presidents and secretaries of Sections in addition to those printed in your columns, and now beg to offer a few general comments. But we hope we shall not be regarded as attempting thus to closure the debate and dismiss it from our minds; rather do we regard the period of discussion, and, we would add, of experiment, as just beginning. It was with the full consciousness that much new enterprise and revision of old procedure were desirable that we invited the recorders and local secretaries to a friendly meeting at Oxford in the spring of this year, and we hope to continue at regular intervals the discussions then initiated and helpfully continued in your columns. We need only add here that as it is an essential function of the British Association to consider and act upon all suggestions tending in any way to the advancement of science, we hope that if you receive further communications for which you cannot find room you will do us the favour to forward them for our consideration.

Proceeding to general comments, we would first express satisfaction that the undoubted smallness of the Cardiff meeting has not been allowed undue weight, even by critics who did not attend and could not appreciate the unusually keen and businesslike quality of the proceedings. Many causes contributory to its smallness are fairly obvious, and incidental to recovery from the war. The high cost of travel and of living (the predatory attitude adopted by one or two of the Cardiff hotels by anticipation was particularly unfortunate), and ultimately the local tram strike, all played their part, and it is to be feared that some of them may continue operative beyond the Cardiff meeting. This we can only endure, reminding those who formerly urged that we should discourage "camp followers" that it is not for them to complain if the attendance is less.

But the important criticisms and suggestions have had a more general character. Some of them (fortunately) cancel out, as when Sir Ray Lankester advocates very careful pre-arrangement and Sir Oliver Lodge the throwing over of the time-table in favour of impromptu discussion. Sometimes the cancelling is kindly done in the same letter, as when Prof. Armstrong, another *laudator temporis acti*, first sings the praises of two long official reigns and then advocates a rapid change of officials. Parenthetically, we may correct a misstatement in his letter; the General Committee did not "relegate to a committee the appointment of a new treasurer"; it only adopted the universal practice of appointing a committee to suggest names to the council. We have, however, no wish to curb permanently the picturesqueness of Prof. Armstrong's exhibitions of hitting out at all and sundry.

But some of the points on which there is division of opinion cannot be simply dismissed for that reason, and chief among them is the very important question of the nature of the Sectional proceedings. Should they be made more "popular"; and can this be done without repelling some of our most regular and most useful supporters?

Now we fully agree that it is a very important function of the British Association to attract the public and impress the nation, but even from this point of view alone it may not be the best method to cater directly for them. Where a frontal attack may fail, more insidious methods may succeed.

One excellent method of attracting the public is to make sure of attracting the nearest living representatives of men like Huxley and Lord Kelvin, who always attracted the public. Now Lord Kelvin used to declare (Sir Arthur Schuster kindly allows us to quote his authority for the fact) that he came to the meetings of the British Association "to hear what everybody else was doing"; and the curtailment of "specialist" papers might easily drive away the very people who ensure the success of the meeting, and in some Sections certainly would do so. We need scarcely labour this point, on which Prof. Eddington has already written much good sense; but we will just add that, in spite of the existence of "special societies" in London, there are many people who have no other chance to hear "what everybody is doing." Thus there are many who are not near enough to London to attend meetings regularly; there is the growing army of science schoolmasters and schoolmistresses who can attend meetings only in the summer holidays, when the London societies do not meet; and there are the numerous members who are interested in more than one Section. All these would benefit by meetings of the Sections even if they were conducted on *precisely* the lines of specialist societies. No one, however, advocates this extreme expedient; undoubtedly the Sectional proceedings should be of a different type, but in trying to secure one good object we must not drop another, and we have reason to believe that the Sectional officers are well aware of the needs and wishes of the members, and are doing their best to satisfy them.

Next, as regards the number of Sections. Without rehearsing all the arguments in detail, it may be accepted as common knowledge that there are weighty considerations on both sides. Who, then, is to adjudicate between them? The people concerned or others? It would seem an almost necessary admission that in each particular case there must be particular considerations which can be truly evaluated only by the people concerned (who must at the same time be impressed, as we all are, by the general undesirability of multiplying Sections), and that a persistent and reasonable application from them must be seriously considered and liberally met. It does not advance science to boycott the younger sciences. Thus at the present time the Physiological Section, having tried a Sub-Section of Psychology for several years, having debated the alternative of a full Section for Psychology in several assemblies, and having met at least one powerful objection, came before the General Committee at Cardiff with an unopposed recommendation for an independent Psychological Section. No dissentient voice was raised in Committee, and no suggestion of further postponement was made. The officers (and staff), on whom fall many of the disadvantages of the multiplication of Sections, scarcely feel that they can oppose such a motion if no other opposition is forthcoming, and if the council concurs it will be to give effect to a preponderance of reasoned opinion.

On the other hand, there was some years ago a movement for the subdivision of Section A. It was fully considered by the Section and rejected, which may be taken as evidence that the tendency to subdivision is not automatic, and therefore to be resisted automatically. The practical requirements of Sections have always varied widely, and the plan of leaving the decision chiefly to the people concerned has much to be said in its favour.

Proposals for joint meetings between Sections and for closer co-operation between groups of related Sections—Mathematics, Physics, and Engineering; Zoology, Botany, and Physiology; Geography and Anthropology; or between any of these (and especially Engineering or Agriculture) and Economics or Education—are not new; they were carefully examined afresh by the council shortly before the war, and the informal conference last spring led to fresh efforts in this direction. Sir William Pope's suggestion of a special advisory body to assist in planning each annual meeting could be realised at any time by joint action of the actual organising committees of the Sections, which are constituted at the close of each annual meeting, and are often consulted by the council in Sectional emergencies during the year.

The presentation of a retrospect of recent advances of knowledge in each Section or in practical applications of scientific work is again a matter for Sectional arrangement. Formerly there were formal reports of this kind drawn up by responsible committees and presented in print for discussion; latterly such a summary has often been the theme of a Sectional president's address, and sometimes of one of the public discourses or the citizens' lectures. It would be easy for related Sections to arrange for such papers in turn, so as to cover the whole field in a cycle of years. In this and similar matters of procedure the policy of the Association has been to give the fullest freedom to the Sectional officers to adopt or modify suggestions coming in general terms from the council or from our friendly critics, and the Sectional officers have every encouragement to exchange suggestions and experiences with one another and with the general officers. The council does its best to select for evening discourses and other general discussions men eminent in science and accomplished exponents of its broader aspects; and the general officers and local executive spare no pains to ensure that they have every facility and convenience that experience may suggest. Occasional failures are, perhaps, inevitable in so difficult an art as public lecturing; the Association may fairly claim to be judged by those discourses which are remembered through the years, and they are not a few.

The circumstances of different localities vary so much that it has been difficult, and would probably be unwise, to insist on close adherence to any one type of programme. Only those who attend habitually know how flexible our arrangements are, how greatly one annual meeting differs from another, or how much of what some of our most outspoken critics desire is actually being done informally in the intervals of a very elastic time-table.

The annual tenure of presidents and vice-presidents of Sections and of the local secretaries introduces a large element of "fresh blood," and many of the best expedients for economy of time and effort have been contributed by annual officers. Recorders and secretaries hold office rather longer, but they are usually chosen from the younger members, and pass on to other duties quite as rapidly as is consistent with the continuity of experience necessary for the smooth working of a meeting. We are making considerable demands on the time of both classes of officers throughout the year, and gratefully acknowledge their keen and loyal co-operation in working out the proposals which we put before them or which result from their own experience.

We are very sensible of the difficulty of including, even into an eight days' meeting, all the opportunities for discussion or for exposition of scientific work which various critics desire; and we would beg that the experience of the meetings in 1910 and 1920, which were, perforce, limited to five working days, may not be regarded as typical of what the Association is trying to accomplish since the war. From these abbreviated meetings, however, and from the varied war experiences of our keenest members, we believe that we have learned some economies of procedure; and as our Edinburgh hosts promise us a normal Wednesday-to-Wednesday meeting in 1921, we have some hope of realising much that has been offered so frankly by your correspondents for our guidance.

To make the annual meeting more widely known in advance and its purpose better understood, we rely, first, on the co-operation of the Press, and especially of scientific and technical periodicals such as NATURE.

There is, we believe, a larger public than ever before for clearly written and accurately informed articles on scientific subjects, and especially on the public services rendered by scientific research, and we should welcome every opportunity of assisting competent reporters and other journalists to obtain trustworthy information on such matters, both at the annual meeting and in advance. But it has been an increasing trouble in recent years that representatives of the Press do not always display either the preliminary knowledge or the journalistic training which might enable them to forecast intelligibly or to chronicle accurately the substance of a scientific discussion, however fully apprehended by other classes of "camp followers." Shorthand, for example, is an accomplishment which we have almost ceased to expect of a Pressman at a Sectional meeting.

We rely on the delegates from our numerous "corresponding societies" to keep those societies informed of the Association's work, to bring on their younger members to our meetings, and to assist the local secretaries in extending the area round the place of meeting from which a full attendance of scientific workers may be expected. The fulfilment of one of our primary functions—to bring provincial scientific workers into touch with specialists gathered from afar—must depend very much upon the corresponding societies of the neighbourhood.

Most of all, however, we look to our ordinary members, and especially to those who are brought into daily contact (as teachers or in business or industry) with younger or less highly trained colleagues or subordinates, to propagate that view of the value and interest of scientific work which alone makes and maintains the fellowship of workers each "doing something else," but able and keen to appreciate the discussions, whether arranged or impromptu, of scientific leaders and men of practical ability who come to our meetings with the same object in view—"to see what everybody else is doing." "Philosophy," it has been said, "begins in wonder," and intelligent wonder, if it is to work its full effect in an eight days' "parliament" or "picnic" of science, must be caught on the flitting wing by that member of ours who is lucky enough to be there when it rises.

J. L. MYRES.
H. H. TURNER.

New College, Oxford, October 24.

THE correspondence which has followed the leading article on "The British Association and National Life" in NATURE of September 16 must have been read with deep interest by everyone who cares for the advancement of science. Since in that article reference was made to some remarks of mine called forth by my experience of the Cardiff meeting, perhaps I may be allowed a few words on the subject.

It seems to me that most of your distinguished correspondents have missed the real point altogether. They have been too much concerned with discussing ways in which the scientific value of the meeting may be increased for the benefit of the scientific man taking part. From this point of view reminiscences, alterations of Sections, joint meetings, and the like are very interesting, and no doubt important. The members of the Association who visit a town have generally a good time, and if by internal reforms they can secure a better scientific holiday no one will grudge it to them. Some of the correspondents appear to think that this should be, if not the sole, at any rate the chief object of the meetings. One of them practically warns the general public off "matters which they do not understand."

The purpose of my original remarks—and, if I am not mistaken, of your article also—was to emphasise the precisely opposite opinion, namely, that whilst the Association served the cause of the advancement of science by bringing workers in it together in circumstances favourable to discussion both formal and informal, yet it also had the duty of bringing before the general public the methods and results of scientific work. There is a cumulative effect here. None of your correspondents can deny that the general public pays us to conduct scientific research. Whether that payment is direct from the rates and taxes or indirect from gifts and bequests does not matter. The public pays, and scientific men are eternally asking for more. The public has, therefore, a right to know what it is getting for its money. Further, if the word "advancement" means anything, and if science has an object at all, what other object can that be than that of making the world a better place to live in? and how can it be advanced unless the results of its progress are made known to the people who are intended to profit by them? Scientific work is either a selfish amusement (as some of your correspondents seem to think) or it is a service of public utility. If it is a service of public utility, then the more the public realises how much it owes to scientific work, the more will the public be disposed to provide money for that work, and, consequently, the more work will be done and the more the public will be benefited. This is the cumulative effect which would follow from an ably directed scientific propaganda.

Science might well consider that favourite text: "Go ye therefore, and teach all nations, baptizing them. . . ." The British Association could be, and ought to be, a mighty engine for this purpose. And be it noted that the advice contained in this text is not only to preach, but also to baptise the converts, which is to bring them into the charmed circle themselves. The volumes of NATURE these fifty years are a record of scientific missionary work. They are full of finely worded appeals regarding the neglect of science, the need for money, the improvement of education, and so forth. But these sermons are not even preached to the converted; they are preached to the priests. What scientific heathen ever reads NATURE?

These considerations are on the high moral plane of duty—the duty which scientific men owe to the nation. Those of your correspondents who think that they are weird, yet beautiful, rare, and expensive, orchids kept in the public hothouses will never agree that they ought to be potatoes and show a good crop. But they will not be so satisfied with the scheme of things if the heating supply fails, and for this reason I should like to descend from the moral plane to the base one of money and to refer to a few facts. These facts would not be mentioned here if it had not already been necessary to state them very publicly in the district that had the honour of entertaining the Association at the recent meeting.

The Cardiff meeting cost the local committee about 2500*l*., and, in spite of all efforts, only about 1800*l*. has so far been forthcoming to meet this expenditure. I would ask your correspondents to consider the reason for this deficit. Cardiff is a wealthy city, and the "docksmen" are well known for their generosity. Large sums of money have been collected recently for such purposes as horse shows, flower shows, and missionary societies from people who mostly knew and cared as much about horses and flowers and cannibals as they do about Einstein. I think the reason is that they understood what these things were for, and they do not know what the British Association is for, because the Association has not seen fit to enlighten them. Another practical point is this. Owing to the decreased purchasing power of money the expenses of the meeting are necessarily two or three times what they were before the war, but the Mæcenas who gave a cheque for fifty guineas before the war does not now give you one hundred and twenty guineas; he still gives fifty.

Your correspondents who are preoccupied with that part of the Association's activities which concerns the meetings and discussions of scientific workers among themselves might perhaps indicate why, if scientific discussion is the be-all and end-all of the Association, the Association should wander all over the country, and even over the Empire, from year to year. Surely it would be more efficient and more convenient to have the annual meeting in the one place in which the Association prides itself on never having met—London.

Dare one suggest that perhaps these "orchids" rather like going to shows?

It is, of course, very easy to criticise and very difficult to construct. It would be presumption on my part to suggest how the Association should proceed to preach the good tidings to all the world, but no one can doubt that the thousand or so of scientific men who attend the meetings year by year could do a great thing for humanity if they chose, and could very soon discover the best means of doing it also. But the methods of the days when, as one of your correspondents recalls, crowds used to appear wherever Huxley was expected to speak are certainly ineffective to-day. To begin with, I am not aware that we have any Huxleys nowadays, and if we had I doubt if they would have that sort of hold on the common or British Association public of to-day. Scientific men should be the last to try to put new wine into the old bottles; it should be an easy matter for them to devise newer and better bottles.

An old member of the Association said to me during the Cardiff meeting: "Well, you may say what you like about it now, but it's a kinema compared with what it was when I first knew it!" I was reminded of this by a chance paragraph in the newspaper the other day describing "the most remarkable film which has ever been made in France," called "Les Mystères du Ciel," and there is no doubt that it made an impression on the Parisian correspondent of the *Observer*, who belongs to a profession which takes a lot of impressing. He lays stress on the fact that some of "the best-known experts have been glad to assist in the making of this remarkable and ingenious film, which has a real educative value." I suppose this will horrify some of our revered seniors, but really the British Association might do worse than kinematise itself a bit further. After all, rightly or wrongly, the kinema does attract and instruct the people more than the Association does, and it certainly collects their money.

R. V. STANFORD.

Radyr, October 23.

Testing Einstein's Shift of Spectral Lines.

I AM not aware that anyone has applied centripetal acceleration to the outstanding Einstein prediction, instead of depending on solar gravitation. It is feasible to whirl a steel disc, 1 metre in diameter, at 3000 revolutions a minute; and this gives a peripheral acceleration five thousand times earth-gravity, whereas solar-gravity is only $25g$.

A few vacuum tubes braced to such a disc would give the effect of continuous illumination; and someone with refined spectroscopic appliances may be willing to try the experiment—unless there is a fallacy in the suggestion.

OLIVER LODGE.

Gullane, October 20.

Recapitulation and Descent.

IN NATURE of October 14 my friend and colleague, Mr. L. T. Hogben, contributes a thoughtful letter on "Recapitulation and Descent," on which you will, perhaps, allow me to make one or two comments. Mr. Hogben traverses the position taken up by Dr. Bather in his address to the Geological Section of the British Association that "recapitulation" in the development of animals is a proof of evolution. His objection is that "experimental breeding" does not justify the inference that a mutant recapitulates the characters of its ancestral type, and that "factorial omission" rather than "the perennial desire of youth to attain a semblance of maturity" is the key to "the omission of some steps in the orderly process."

Now I fully agree with Mr. Hogben that if by "experimental breeding" and "genetic investigation" we mean the endless and wearisome repetition of the crossing of "Mendelian mutants" with one another and with the parent species, we shall wait until doomsday before we obtain any light on recapitulation, or, indeed, on any of the other broader aspects of the evolution theory.

When the upholders of a theory confess, as does the leading British Mendelian, that it is totally unable to throw any light on the origin of adaptation —which is, after all, the very heart of evolution—the biologist must indeed regard it as bankrupt, at any rate if it claims to be a full exposition of heredity. Not all "genetic investigation," however, is of the Mendelian type, and quite recently some patient researchers claim to have accomplished something like evolution on a small scale experimentally, and to have found traces of recapitulation. I am aware that these results have been regarded by Mendelians with scepticism, as I think quite unfairly; but until the Mendelians have repeated the experiments and disproved the results, these results must stand as the relevant facts. They are beginning to come in from widely divergent sources, and the easy method of getting rid of them by doubting the *bona fides* of the researcher is no longer available.

The great evidence in favour of the reality of recapitulation is that in our survey of the animal kingdom we encounter facts which literally compel every naturalist who encounters them to interpret them in this way and no other. When, for instance, we find a tortoise with a soft, flexible skin devoid of the bony plates which support the carapace of all his brethren, and it transpires that this tortoise enters on his career as an ordinary tortoise with a regulation carapace, what other explanation than recapitulation can be possibly entertained? When, further, we find that Cœloplana, which looks like a flat-worm, and Tjalfjella, which resembles a Sponge or an Ascidian, both begin their free life as exquisite little Cydippid Ctenophores, does anyone consider it possible to doubt recapitulation, and therefore evolution? This may not be logical, but it is convincing, and as Huxley long ago said: "If a man chooses to maintain that a fossil oyster-shell is a concretion, and not the remains of an organism, it is impossible to drive him from his position by logic."

I differ totally from Mr. Hogben in believing that the "omission of factors" has anything to do with the shortening of the developmental process. Rather I am convinced that this shortening is akin to the greater quickness with which an habitual act is performed after countless repetitions. If, for instance, we compare the degenerate eyes met with in the pathological cripples known as Mendelian recessives with the degeneracy due to loss of function owing to changed habits, we meet with a totally different picture in the two cases, as anyone consulting the literature can see.

Nor can I agree with Mr. Hogben that much of the reasoning of the past originated in an emotional recoil excited by popular prejudice. The reasoning of the past reflected the burning impression created by the impact of myriads of new and unsuspected facts, and we owe Dr. Bather a debt for pointing out in his brilliant address that the old methods are perfectly sound *if properly applied*. At first they were applied in a wild and careless manner, and hence the reaction against the doctrine of recapitulation which set in, and of which Adam Sedgwick in his later years was a victim. But this reaction was no more justified than would be a reaction against Egyptology because some of the earlier Egyptologists drew rash conclusions from insufficient facts and sketched out

fascinating hypotheses which later proved to be baseless.
E. W. MACBRIDE.

Imperial College of Science and Technology,
South Kensington, London, S.W.7, October 22.

British Laboratory and Scientific Glassware.

THE question of the manufacture of laboratory and scientific glassware in this country is now receiving the attention of the House of Commons, together with other key industries. This matter has been the subject of considerable correspondence in NATURE, and I feel that readers of this journal will be interested to know what progress has been made in this work.

The advance made in the manufacture of laboratory and scientific glassware in Great Britain during the last five years is not only remarkable, but is also a monument to the capacity and ability of the British scientific worker. It is unnecessary to point out here the importance and necessity of scientific work or of the vessels and instruments that men of science use. That the latter must be of the finest quality and manufacture is indisputable.

At the outbreak of war men of science were absolutely dependent on supplies of German glass. They realised the danger, and at once stepped into the breach that the British manufacturer, unaided, was unable to fill. As a result of their efforts we now have the nucleus of a considerable industry in this country. While the supply is not yet equal to the demand, rapid progress has been, and is being, made.

Men of science are always critical of one another's work, and the production of these laboratory glasses has naturally led other workers to test and compare their properties with those of German and other makes. These results have been published in purely technical journals, but I feel that they have not yet had the publicity given to them that they deserve. The results of these tests are really remarkable, and prove quite conclusively that, in spite of the short time that the industry has been established, British laboratory glassware is the finest in the world. The results have never been challenged in any way, and go to show that the widely and cleverly advertised properties of German glassware are not quite so good as they have been made to appear, and that the British manufacturer has not merely equalled their best, but surpassed it.

The reports of the series of tests referred to are contained in the Journal of the Society of Glass Technology, the references being as follows:—Vol. i., p. 153: "The Attack of Chemical Reagents on Glass Surfaces, and a Comparison of Different Types of Chemical Glassware." Vol. ii., p. 219: "The Resistant Properties of some Types of Foreign Chemical Glassware." Vol. iii., p. 129: "Further Investigations of Chemical Glassware." These researches have been carried out by a department of Sheffield University.

The glasses tested have been classified (vol. ii., p. 230) under the headings "Good," "Moderate," and "Bad," and include Jena glass, Greiner and Friedrich's "R," Koln Ehrenfeld's, Swedish, Italian, French, American, and British. Of these only seven (two German, two American, and three British) remain in the "Good" class in every test. The tests include the action of (1) boiling water, (2) boiling water under pressure (autoclave), (3) $2N$-NaOH, (4) $N/10$-NaOH, (5) $2N$-Na_2CO_3, and (6) boiling HCl.

The action of boiling water at atmospheric pressure is so small on all seven glasses as to be, in the opinion of the authors of these researches, within experimental error, and is, therefore, negligible for comparative purposes.

An analysis of the table of results referred to above shows that for the remaining five tests the order of merit of the various glasses for general use is as follows: (1) A British glass. (2) A German glass. (3) A British and an American glass. (4) An American and a German glass. (5) A British glass.

This result speaks for itself, and it should be added that neither of the two German glasses in this list is Jena glass, which was found to occupy a comparatively low position in the table of results.

One of the great troubles which the manufacturer has had to face was that he was making this extraordinary attempt, not in normal, but in abnormal, times, when the supplies of raw materials and trained and unskilled labour were not available. Men skilled in the difficult art of "blowing" were almost unobtainable, yet these difficulties were gradually overcome and continued improvements made, until to-day the best British chemical glass bears comparison, from every point of view, with the products of the rest of the world.

In the early days many complaints were urged regarding the quality of the finish. This was only to be expected. It is obvious that skilled labour cannot be trained in a day, but I have no hesitation in saying that the finish of the majority of the best British makes of resistant glass is now as good as, if not better than, that of German glass of comparable composition.

One feels that the British manufacturer has at times been blamed for producing an inferior article. Unbranded glass has often been sent to chemists as British ware, whereas all the best makes of British glass are stamped with the name of the firm making it.

Unfortunately, those who were patriotic enough to manufacture this glass during the war are in danger of losing the result of their labours. Your readers know the heavy cost of experimental and research work, and will naturally realise that the British manufacturer is extremely anxious lest the results of this work should be permanently lost to the country. It is for this reason that the British manufacturer asks that the Key Industries Bill should be passed as soon as possible, to enable him to train more labour and to place this industry on a permanent and satisfactory footing.

S. N. JENKINSON,
President of the Society of Glass Technology.

"Rondels," Cookham Dean, Berkshire,
October 18.

The Behaviour of Time-Fuzes.

IT might appear that in my article on "The Behaviour of Time-Fuzes" in NATURE of October 14 I was describing my own researches. I wish to correct any impression of that kind. The original draft of my article was unsigned, but, unfortunately, I allowed the author's name (inserted by the Editor) to remain in the proof. The experiments described were made by a variety of people at Woolwich, at the National Physical Laboratory, at Cambridge, at University College, London, at Portsmouth, and elsewhere; and not least of the credit for the progress made in our knowledge of fuze-behaviour is due to certain officers of H.M. Army and Navy, on the Ordnance Committee, at the Ministry of Munitions, and at H.M.S. *Excellent*. My article, however, was intended not to apportion credit, certainly not to claim it, but to describe what I personally regard as the leading lines of development of a strange and interesting scientific by-product of the war.

A. V. HILL.

45 The Downs, Altrincham, Cheshire,
October 21.

The Floor of Anglesey.[1]

By PROF. GRENVILLE A. J. COLE, F.R.S.

THE thoughts of travellers across Anglesey in the Irish mail-train are usually controlled by a previous vision of the breakers rolling in on Colwyn Bay; yet many must have been attracted by glimpses of grey homesteads set on elongated mounds, farmlands alternating with strips of marsh and moor, and here and there the "desert scenery" of some sunlit groove, bounded by low terraces of ancient rock, along which the sand has drifted inwards from the sea. In 1895 Mr. Edward Greenly retired from the staff of the Geological Survey to devote himself to the geology of the island. For twenty-four years he pursued his investigations, recording his results line by line upon the six-inch maps. The antique complex, offering problems similar to those faced by him in the Scottish highlands, was his first object of research; but nothing in Anglesey proved foreign to his aim as he carried out his work. The result is a memoir presented by its author to the Geological Survey, and thus to the general public, accompanied by a map reproduced on the scale of one inch to one mile. Mr. Greenly's generosity has led him even to provide much of the cost of publishing these two handsome volumes. Geologists in many countries will associate themselves warmly with the thanks so well expressed by Sir Aubrey Strahan in his preface. May we be allowed to join also in the author's gratitude to Mrs. Greenly for her co-operation in long years of preparation?

FIG. 1.—The folding of the Mona complex, from the South Stack, Holyhead. Height seen 445 ft. From "The Geology of Anglesey," by permission of His Majesty's Stationery Office.

A comparison of the map, which is so clearly produced, in spite of all its detail, with the hand-coloured sheets issued in 1852 will best reveal the changes of view that studies in other areas have brought about. When J. F. Blake, in 1888, read his memorable paper on "The Monian System of Rocks," we were still in the grip of what may be called the pre-cambrian controversy. Lapworth had recently published his work on the north-western highlands of Scotland; the Geo-

[1] (1) "The Geology of Anglesey." By Edward Greenly. (Memoirs of the Geological Survey.) Vol. i., pp. xl+388+plates i–xxvi; Vol ii., pp 389–980+plates xxviB–lx+16 folding plates. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd., 1919.) Price, two vols., 3 guineas net.

(2) Geological Survey of England and Wales "Anglesey." Colour-printed map, one inch to one mile. (Southampton: Ordnance Survey Office, 1920.) Price 2s. 6*d*.

logical Survey, after a natural hesitation, had frankly accepted and developed his conclusions; but many felt that to surrender large areas of "altered Lower Silurian" on our maps to combatant claimants was a first step in the disintegration of the British Empire. On the other hand, the word "mica-schist" was reserved by others for a type of sediment that had not been repeated since pre-cambrian times. Mr. Greenly came into the field without any of these predilections, and his memoir on Anglesey represents the reasoning of an absolutely unhampered mind.

His first volume is devoted to the "Mona complex," which is regarded as probably pre-cambrian (p. 142). The details of folding and of foliation in the successive divisions of the complex, and of the spilitic lavas, with their associated red jaspers, are finely illustrated in the author's plates. Two of his broader landscapes have been selected for the present notice. The word "encarsioblast" is introduced on p. 43 for a lenticular crystalline growth in a schist, in which the cleavages and planes of intergrowth are at a high angle to the general foliation, features indicating that such growths are among the latest features of reconstruction. When a term like this is written in international Greek, cannot we get rid of "hornfels" and "augen" from British usage? The

Fig. 2.—Typical scenery of the Mona complex; Amlwch Port Moor. From "The Geology of Anglesey," by permission of His Majesty's Stationery Office.

throughout. The green rocks, including the pillow-lavas of Newborough, are included in one of the earliest divisions—the Gwna "group." With J. F. Blake the author recognises (p. 896) this "group" in Howth, in eastern Ireland—a view that carries with it far wider suggestions. Gneisses underlie the Mona complex, but an unconformity has not been traced; the typical gneiss (p. 133) is composite, consisting of a granitoid element veining and permeating an originally sedimentary series, which includes even limestones. The resemblance with the gneiss of eastern Sutherlandshire and Forfarshire is close metamorphic rocks of Anglesey are admirably dealt with, and the glaucophane-schists are held (p. 120) to be modifications of the Gwna spilitic lavas.

The geological systems in Anglesey range up to the Coal Measures, in which the barren red strata of Malldraeth and the Menai Strait are now included (p. 668); but we must pass on to the features impressed on the island by denudation and deposition since Cretaceous times. Mr. Greenly (p. 777) shows the probability of a large outlier of Chalk, resting on Jurassic beds, remaining in the sea between the Isle of Man and

Lancashire. The Cretaceous sea lay over Anglesey, and Cainozoic folding has carried its base (p. 895) to some 700 or 800 ft. above the present sea-level. No great warping is needed to prolong this base over Snowdon, and the excavation of the deep valleys of the highland is ascribed, like the levelling of the "Menaian platform" (p. 783), to Pliocene denudation. The contrast between Snowdonia and the lowland of Anglesey is not due to differential erosion, but to the curve of the Cainozoic anticline, rising to the east.

The details of the glaciation of the island are now for the first time adequately dealt with, and with this last hint of the additions made by Mr. Greenly to British geology, our notice must, ever gratefully, conclude.

Food Requirements and the Minimum Wage.

A WELL-KNOWN and trusted Labour leader remarked, not very long age, to the writer of the present article, *apropos* the scientific assessment of food requirements, that "Science leaves me cold." Labour, in common with other parties in the community, has to learn that, unpalatable or no, scientific truth must be faced squarely. Unless the conduct of affairs be laid securely on a sound, scientific basis, and not on sentimentalism, the social edifice will collapse. It is constantly forgotten that the scientific dictum of to-day usually becomes the hackneyed commonplace of to-morrow.

Much as the recent proposal to base wages on a sliding scale, rising and falling with the cost of living, is resented, it is an absolutely sound doctrine, and probably the only practicable base to work from without inflicting undue hardship upon the community at large. Many workers seem to resent the utilisation of this base on the ground that it would reduce them, in their opinion, to the level of animals. This is a perfectly unsound deduction, and not only is it unsound; it is unwarranted. The introduction of such a scientific assessment of wages does not reduce the status of the worker.

We all have a right to live, and life is maintained by an adequate ingestion of food. The only practicable basis for the fixation of the level of the minimum wage would seem to be the cost of living. It has been contested by many people who are unacquainted with the methods of science that as all humanity is neither of the same sex nor of equal age and size, and as the work performed by various classes of the community varies within wide limits, as regards both severity and duration, it is impossible to lay down standards which will be uniformly applicable. So far as the *minimum* wage is concerned, there is absolutely no difficulty.

It may be well to state briefly, in the first place, the methods by which science has reached its definite conclusions, as the whole question is dependent on the fact that food is consumed as a source of energy for internal and external work. The demands for internal work are fairly definitely known, and are a function of the mass of the active tissue (mainly muscle) of the body. This fraction will be considered under the terms of basal or standard metabolism—*i.e.* the energy requirements when the body is in a state of complete repose. In order to assess the amount of work done, both internal and external, and the amount of food which must be consumed in order to cover this, it is obvious that there must be some common unit to which everything is reduced. The unit most generally utilised is the large calorie, as all forms of energy may finally be reduced to terms of heat. The large calorie is the amount of heat required to raise 1 kilo. of water from 15° to 16° C.

The number of Calories contained in a unit mass of food can be determined directly by burning the food in a special small steel chamber (the bomb calorimeter) where the heat liberated by the combustion of the food material is taken up by water contained in a water-jacket, the rise of the temperature of the water being measured by a sensitive thermometer. The amount of energy given off by the body can also be determined, either directly by measuring the amount of heat given off as heat and estimating the external work done in work units, which, in turn, can also be stated in terms of heat, or indirectly by means of the exact analysis of the expired air, where each litre of oxygen consumed can be calculated in terms of Calories.

The cost of the internal work, the basal metabolism, is, as already mentioned, a function of the amount of active metabolic tissue present in the organism. It is obvious that the actual amount of such tissue cannot be directly determined in the living subject. Formerly it was assumed that the weight of the individual gave a good approximation, and that therefore the Calorie output per kilogram body weight—*i.e.* including active tissue like muscle and inactive tissue like fat—would be the measure of the cost of internal work. Recent research has shown that such a value is an approximation only; that much more uniform values can be obtained if the weight-factor is correlated with the age and the height of the individual. The basal metabolism by the use of suitable formulæ can now be stated in terms of Calories per square metre surface of the body. The mean of a large number of determinations has shown that the basal metabolism of a man between the ages of twenty and fifty on an ordinary diet is 39·7 Calories per square metre surface per hour. It is generally accepted that the "average" man has a surface of about 1·77 square metres, and, therefore, a daily basal metabolism of approximately 1700 Calories—*i.e.* as cost of internal work.

This method of assessing the basal metabolism enables us to deal with the fact that workers vary markedly in physical condition. An objection to the use of a general average for all workers in all trades is that it is frequently found in practice that a certain type of man tends to drift into one type of occupation and a different type into another. It is a case, in the majority of instances, of the survival of the fittest; if a worker is not suited to the trade he has selected he eventually seeks another. But, in spite of this possible segregation—and nothing could be more simple than to make definite allowances if these were required—it is found that the general law of averages can be applied with success.

In order to determine the total daily output of energy by any individual, to the cost of the internal work must be added the increment due to the external work done. In spite of the widely expressed belief that it is quite impossible to correlate the daily work done by different types of workers, let us say that of a postman, a dock labourer, a bricklayer, and a trawler deck-hand, nothing is more easy, provided the appropriate tests are carried out. It is true that the amount of energy spent in the form of external work varies very markedly with the type of work performed and the conditions under which it is carried out. It may range from the low cost of sedentary work in a warm office or workshop, to the other extreme of hard manual labour under unfavourable conditions in the open air. One of the attempts at the classification of external work is given in the report on food requirements by the Food (War) Committee of the Royal Society. The figures given are net daily (eight-hour) figures to be added to the cost of the basal metabolism.

Sedentary	Less than 400 Calories	
Light work	400 to 700	„
Moderate	700 „ 1000	„
Heavy	1100 „ 2000	„

In certain types of work the 2000-Calorie limit may be exceeded.

Then, finally, there is the question of sex. Experimental work has definitely shown that the basal metabolism of women is about 7 per cent. below that of men, and, further, that, except in the lightest forms of manual work, the amount of external work performed is below that of men. It is generally held that the total energy output of women for the twenty-four hours is 17 per cent. below that of men. This divergence between the male and female metabolism can ultimately be referred back to two simple factors: (1) the relative weights, and (2) the relative proportion of muscle in the two sexes. As regards the first, it is common knowledge that the average woman weighs less than the average man; and, as regards the second, it is equally well known that the average woman is not so muscular as the average man—the average muscle in the case of man forms about 45 per cent. of the total weight, whereas in the woman it forms only about 38 per cent. It therefore follows that the expenditure of energy will be greater in the case of the male, making the assumption, of course, that each worker, male and female, is working at his or her optimum rate.

It is to be regretted that in this class of investigation, although a certain amount of work has been done, Britain has not played a prominent part. Compared with the work carried out both on the Continent and in the United States, the experimental work here has been almost negligible. The special apparatus and the facilities for such research have been lacking. The Inter-Allied Scientific Food Commission, which sat during the later stages of the war, did recommend that a special institute for such research should be founded in each country, but, so far, nothing has been done here.

As regards the practical aspect of the question, the investigations of Miss Lindsay and Miss Ferguson in Glasgow have thrown considerable light on the problem. Before the war, for example, it was found that the *average family* in receipt of 1*l*. per week could obtain, expending, it is true, about 73 per cent. of the total income on food, 3163 Calories per "man"[1] per day, roughly at the rate of 453 Calories per penny. Early in 1917 an income of 1*l*. 10*s*. did not suffice. At present, in a recent Government return (*Labour Gazette*, September, 1920), it is shown that the cost of food alone is 167 per cent. above pre-war level, and if the overall expenditure be taken there is an increase of 161 per cent. The following table, from data kindly supplied by Miss Ferguson, gives a good idea of the change in the cost of living during the past six years:—

Yield of Energy in Calories per 1d. Purchasable at Glasgow: Retail Prices.

Commodity	June, 1914	June, 1915	Nov., 1915	June, 1916	May, 1917	Nov., 1917	Feb., 1920	July, 1920	Oct., 1920
Flank beef ...	132	99	99	91	79	99	74	46	66
Flank mutton	132	88	88	88	103	107	95	—	71
Bacon ...	256	203	187	179	129	100	95	90	96
Cheese ...	241	171	196	152	89	111	83	89	94
Milk ...	—	—	—	—	90	68	49	39	60
Margarine ...	659	587	587	504	298	255	298	298	277
Bread ...	810	607	607	572	405	527	495	384	405
Flour ...	1155	770	798	722	471	722	722	722	510
Oatmeal ...	1512	753	850	814	331	467	404	—	360
Barley ...	825	660	550	471	330	412	314	314	314
Split peas ...	827	552	414	325	325	297	325	325	366
Haricot beans	640	640	533	457	116	271	406	457	582
Lentils ...	648	463	216	463	217	217	271	325	271
Rice... ...	815	815	815	652	466	466	408	233	251
Sugar ...	930	531	496	372	347	317	228	133	207
Potatoes ...	542	542	723	271	244	427	299	142	375

In view of the fact that, of the weekly wage of the workers earning 50*s*. a week or less, at any rate of those with families, 50 to 60 per cent. of the income is legitimately spent in the purchase of food, it is suggested that the total

[1] A family composed of father, mother, and children can be reduced to terms of "man" by the use of appropriate and well-established factors. Se Royal Society Food Requirements Report.

cost of living should be the dominant factor in the determination of the level of the minimum wage. Such a mode of assessment would also form an equitable basis for the determination of the wage of the skilled worker, in so far that the increment to be added in payment of (1) skill, (2) compensation for work carried out under unpleasant or unhygienic conditions, or (3) extra-heavy work, would be simply an addition to the minimum wage.

It is unquestionably true that there ought to be a statutory minimum wage. It is the unskilled worker who suffers most. No matter what the trade or occupation, it can be confidently asserted that, as a general rule, it will be found that the unskilled labourer is expending most energy and receiving least pay.

The assumption has been made that the purchase of food and the production of external muscular work are terms which are strictly interchangeable, and within the limits of the minimum-wage-earning class this is true. Objection to the proposal to use food consumption as the basis of wage fixation might legitimately be raised on the ground that, with the great majority of wage-earners, the purchase of food is not confined to the purchase for their own needs, but also for those of a family or other dependents. There is the further difficulty as to whether the minimum wage for men and women should be identical. There is absolutely no question about the fact that the average woman worker does not expend the same amount of energy as the average man, but this may be offset by another factor of wide application, that the majority of working women carry on at the same time housework in their own homes, where the expenditure in energy may easily compete in severity with the work done outside.

Science may seem at times to be cold and unsympathetic, even harsh, but, nevertheless, it is only when the facts are observed in a clear and unimpassioned manner that the truth can be found. Far from viewing man as a mere machine for the conversion of the latent energy of food into the potential energy of work, science is fully alive to the fact that this is only one aspect of vital activity, that there is a psychic side of life —everything that makes up the environment— which plays an equally important part in the life-history.

The purely energy side of the subject cannot be the sole criterion for the determining of wages. Food alone will not suffice to keep men going; it must be consumed under conditions which are satisfactory—conditions, it is true, which vary, at present, with the social status of the individual. There must be a sufficiency of money for a reasonable expenditure on various small luxuries, for entertainment, and for the various amenities of life, the absence of which makes life for the majority of people scarcely worth living. There is no question, then, as many Labour leaders seem to imagine, that an attempt is being made to reduce the manual worker to the level of serfdom.[2]

E. P. C.

[2] The Editor has very kindly directed the writer's attention to a footnote in Mr. H. G. Wells's "Outline of History" (p. 519; Cassell and Co., 1920) with reference to an experiment of the Oneida Silver Co. In the assessment of the weekly wage reference is made to the cost of staple commodities and common necessities, and the worker receives his wages *plus* a percentage representing the advance of the cost of food, etc., from a standard value.

Obituary.

DR. MAX MARGULES.

THE news of the death of Dr. Max Margules on October 4, which reached this country a fortnight ago, is rendered particularly sad by the announcement in Tuesday's *Times* that "his death was due to starvation. He had been living on a pension of 400 crowns a month (which is equivalent to 8s.), and he was too proud to beg for assistance." Dr. Margules was born in 1856 at Brody, in Galicia. After studying at Vienna and Berlin, he entered the Austrian Meteorological Service in 1880, and became secretary of the Institute at Vienna in 1890.

In 1882 Lord Kelvin suggested that the explanation of the regular semi-diurnal variation of the barometer, which has a range of more than two millibars in equatorial regions, might be found in the coincidence of a free period of oscillation of the atmosphere with the period of the solar gravitational tide. Lord Rayleigh in 1890 showed that *if the rotation of the earth were neglected*, a rough computation of the free periods led to values of 23·8 and 13·7 hours, so that Kelvin's hypothesis became at any rate a possibility, although the actual values obtained by Rayleigh would have indicated a bigger diurnal and a smaller semi-diurnal barometer variation. Margules, in the same year, attacked the problem of computing the pressure oscillations of the atmosphere on a *rotating* globe, and found that for an atmosphere with a temperature of 268° absolute (−5° C.) the free period was exactly twelve hours.

In 1892 and 1893 Margules contributed to the *Sitzungsberichte* of the Vienna Academy a series of masterly papers on the motion of the air on a rotating spheroid. These papers are little known to English meteorologists, as they were not included in the collection of papers and translations issued by the Smithsonian Institution in the volumes of "Mechanics of the Earth's Atmosphere."

Margules contributed to the Year Book of the Meteorological Institute of Vienna for 1903 a comprehensive discussion of the energy of storms. He showed that the atmospheric phenomena associated with storms would arise if two masses of air of different temperatures were in juxtaposition. The situation would be unstable, and in passing from this unstable situation to a stable one the potential energy would be reduced, part of it being converted into the kinetic energy of the ensuing "storm." This paper contains the germ of the theory of line squalls, of the development of cyclones, of polar fronts, and so forth. It includes computations of the horizontal velocities which would result from various distributions of pressure and temperature, and shows that actual distributions would lead to velocities of 50 miles an hour. Margules summed up his conclusions in the sentence: "So far as I can see, the source of storms is to be sought only in the potential energy of position."

Margules retired from active participation in the work of the Austrian Meteorological Service during the directorship of the late Prof. Pernter, and applied himself to the study of chemistry. He fitted up a small laboratory in his own house, where he lived in comparative retirement. The present writer was saddened to see him there in 1909 entirely divorced from the subject of which he had made himself a master. Meteorology lost him some fifteen years ago, and is for ever the poorer for a loss which one feels might and ought to have been prevented. E. GOLD.

THE *Engineer* for October 22 records the death of MR. C. J. BOWEN COOKE on October 18 in his sixty-second year. Mr. Bowen Cooke was educated at King's College School, London, and on the Continent, and thereafter spent the whole of his life in the service of the London and North-Western Railway. After serving a pupilage under the late Mr. F. W. Webb, he was appointed assistant in the running department, and rose to be its superintendent. In 1909 he was appointed chief mechanical engineer, and thereafter was responsible for the design of several important types of locomotive engines. The chief of these was a non-compound superheater engine weighing 116 tons and having four cylinders; this engine was fitted with Walschaert's valve gear. Mr. Bowen Cooke took a very active part in the development of the manufacture of munitions of war in railway workshops, and was made C.B.E. in 1918. He was a member of both the Institutions of Civil and Mechanical Engineers, a Justice of the Peace and County Councillor for Cheshire, and a major in the Engineer and Railway Staff Corps. He was the author of two books on locomotives, and also of a paper on the mechanical handling of coal for British locomotives, read at the Institution of Civil Engineers in 1912.

PROF. HANS PEDR. STEENSBY, whose death at the early age of forty-five is announced by the *Times*, was professor of geography in the University of Copenhagen. He was chiefly known for his researches on the Eskimo in relation to their environment, most of which appeared in *Meddelelser om Grønland*, and included "Contributions to the Ethnology and Anthropogeography of the Polar Eskimos" (1910) and "An Anthropogeographical Study of the Origin of Eskimo Culture" (1917). Prof. Steensby came to the conclusion that the Eskimo were originally an inland people dwelling in the tundra, probably in the vicinity of the Great Slave Land and Coronation Gulf, and that their culture was originally an Indian hunting culture adapted later to the conditions of the Arctic shores. He also wrote on the early voyages of the Norsemen, and was returning from America, where he had been in connection with his investigations into this subject, when his sudden death at sea occurred.

Science announces that PROF. SAMUEL MILLS TRACY, agronomist of the United States Department of Agriculture, died at Laurel, Miss., on September 5, aged seventy-three years. Prof. Tracy was born at Hartford, Vermont, and graduated from Michigan State Agricultural College in 1868. From 1877 to 1887 he was professor of botany and agriculture at the University of Missouri, and from 1887 to 1897 director of the Mississippi Agricultural Experiment Station. Since that time he had been attached to the United States Department of Agriculture. He was a fellow of the American Association for the Advancement of Science, in the work of which he took an active part, and a member of the New Orleans Academy of Science and of the Botanical Society of America. Among Prof. Tracy's works are "The Flora of Missouri," "The Flora of Southern United States," and numerous bulletins issued by the Mississippi Experiment Station and the United States Department of Agriculture.

SIR CORNELIUS NEALE DALTON, whose death occurred on October 19 at seventy-eight years of age, was Comptroller-General of Patents from 1897 to 1909. When, in 1901, the Committee appointed by the Board of Trade to inquire into the working of the Patent Acts reported in favour of an examination for novelty, within certain limits, being undertaken by the office, Sir C. N. Dalton laid down the lines on which the examination has since been conducted, and recommended and carried out the necessary scheme of reorganisation. His strength lay in his tact, energy, and power of organisation, and these enabled him to carry out alterations in the law and practice of patents, though it may be doubted whether the changes were to the advantage of the inventor. He was hon. D.C.L. of Oxford, was created K.C.M.G. in 1908, and was chairman of the council of the East London College.

THE death of DR. ANTON WEICHSELBAUM, professor of pathological anatomy at Vienna University, at the age of seventy-five years, occurred on Friday, October 22.

Notes.

IMPORTANT changes are announced at the Ministry of Agriculture, the effect of which is the promotion of Mr. F. C. L. Floud to be Permanent Secretary and the liberation of Sir Daniel Hall from office work so that he will be able to keep in close personal touch with agricultural developments in this country as well as abroad, and devote his whole time to the organisation of agricultural education and research. Sir Daniel has been associated with this work throughout his whole official career. The scheme now in operation comprises four essential parts:—(1) Research institutions, where knowledge is gained and agricultural science systematically developed and put into such form that teachers and experts can use it. At first this work was distributed among a number of university departments, but of recent years there has been a tendency to concentrate it at a few institutions owing to the necessity for bringing individual workers into closer personal contact with each other and with the large-scale problems of the farmer. (2) Agricultural colleges, where experts and large farmers will be trained, receiving a three years' course of instruction of university character. Most of these colleges are associated with universities which award degrees in agriculture; for students who do not wish to take degrees there is a diploma course requiring a high standard of technical work. (3) Farm institutes for small farmers and farm-workers who cannot spare three years for college, but have some practical knowledge and are unable or unwilling to go through the ordinary college course. These institutes aim at giving sound courses of instruction on soil, manure, crops, animal husbandry, etc., but it is usually presumed that the student will take up farming in the area served by the institution, and for which the instruction is specially appropriate. (4) Advisory officers. In each county arrangements are made whereby farmers, smallholders, and others may consult the agricultural expert appointed by the county authority in regard to any difficulties they may meet with in their work. The expert is in a position somewhat similar to that of the general medical practitioner, and usually finds that he can deal with a large number of the cases presented to him. He is, however, in touch with the colleges, research institutions, etc., and can always obtain expert advice in any particular problem of special difficulty.

PROF. T. H. PEAR has been elected an honorary secretary of the Manchester Literary and Philosophical Society in succession to Prof. C. A. Edwards.

MR. J. A. BRODIE will deliver an inaugural address at the opening meeting of the one hundred and second session of the Institution of Civil Engineers on Tuesday, November 2, at 5.30 p.m.

THE *British Medical Journal* announces that the fourth congress of the Far Eastern Association of Tropical Medicine will be held in August, 1921, at Batavia, the capital of the Dutch East Indies, under the presidency of Dr. W. T. de Vogel.

THE University and the Royal Academy of Sciences of Bologna will hold a joint commemoration service for the late Prof. Righi in the lecture hall of the University on November 1. This will be the fortieth anniversary of Righi's first association with the University, and an oration will be delivered by Prof. Luigi Donati, director of the Royal School of Engineering.

A JOINT meeting organised by the Faraday Society and the Sheffield Section of the Institute of Metals will be held at the University of Sheffield on Friday, November 19, to discuss papers dealing with various aspects of electro-plating. Communications are promised from representatives of the scientific side of the electro-plating industry in London, Birmingham, and Sheffield Anyone desirous of taking part is invited to communicate with the Sheffield local hon. secretary of the Faraday Society, Dr. F. C. Thompson, Department of Applied Science, University of Sheffield.

WE learn from the *British Medical Journal* that, through the gift of an anonymous fellow, the Royal Society of Medicine has been able to institute a triennial gold medal open to medical practitioners throughout the world. Sir Almroth Wright has been chosen as the first medallist, and the presentation will be made to him by the president of the society, Sir John Bland-Sutton, at 5 p.m., on Thursday, November 11, at 1 Wimpole Street, and Sir Almroth Wright will afterwards give an address on medical research.

AT the annual meeting of the Royal Society of Edinburgh, held on October 25, the following were elected as office-bearers and members of council:—*President:* Prof. F. O. Bower. *Vice-Presidents:* Prof. D. Noël Paton, Prof. A. Robinson, Sir G. A. Berry, Prof. W. Peddie, Sir J. A. Ewing, and Prof. J. W. Gregory. *General Secretary:* Dr. C. G. Knott. *Secretaries to Ordinary Meetings:* Prof. E. T. Whittaker and Prof. J. H. Ashworth. *Treasurer:* Dr. J. Currie. *Curator of Library and Museum:* Dr. A. Crichton Mitchell. *Councillors:* Prof. R. A. Sampson, Prof. J. Lorrain Smith, Dr. W. A. Tait, Surg.-Gen. W. B. Bannerman, Mr. H. M. Cadell, Prof. A. R. Cushny, Prof. F. G. Baily, Mr. G. J. Lidstone, Dr. R. Campbell, Prof. J. C. Irvine, the Hon. Lord Salvesen, and Prof. J. A. Thomson.

WE referred in our issue of September 2, p. 26, to a statement received from a correspondent in India that Sir Alfred Bourne was to be succeeded in the directorship of the Indian Institute of Science, Bangalore, by an administrator with no scientific experience, and we remarked that such an appointment would be greatly deprecated by scientific workers. By the statutes of the institute, the council appoints a committee at home to make nominations, and from the nominations sent out it selects a name for the approval of the Viceroy, who is patron of the institute. If the council sent home a nomination for the office, it apparently went beyond the spirit of the statutes, but, in any event, we understand that no director has yet been appointed to succeed Sir Alfred Bourne. We trust that the post will be filled by a man who combines administrative capacity with scientific knowledge.

One of the most valuable contributions to the study of magic in the Malay Peninsula was the description by Mr. W. W. Skeat in his "Malay Magic" of the methods by which the soul of the rice plant was evoked in the seed grain. Our knowledge of these practices has recently been advanced by the papers contributed by Mr. R. O. Winstedt to the *Journal of the Federated States Museums* (vol. ix., part 2, July, 1920) descriptive of similar rites in Upper Perak and Negri Sembilan. In the former region the seed is washed and cleansed with limes, and the farmer makes the invocation: "Greetings be to thee, God's prophet Solomon, King of all the earth! I would sow seed rice. I pray thee, cherish it from all danger and hazard!" At harvest he says: "Greetings be to you, gnomes of the latter days, gnomes of the beginning, gnomes one hundred and ninety! Get ye back and aside! If ye turn not aside, I will curse you!" After the regular invocation the soul of the rice will come in the form of a grasshopper or other insect with the sound of a breeze. When the rice-soul is invoked at harvest the magician must wave a white cloth, so that the rice-soul shall not fall on and crush one of the party at her coming. This valuable contribution supplies additional information on the subject fully discussed by Sir James Frazer in the last edition of his "Golden Bough."

The origin of cancer is discussed by Dr. Alexander Paine in a paper in the *Lancet* of October 2 last (p. 693). The conclusion Dr. Paine arrives at is that cancer is due, not to the action of a specific parasite, as has been suggested, but to a disordered growth of epithelium caused by various chemical or physical irritants, the most important being the toxins or poisons of micro-organisms. Dr. Paine considers that the origin of cancer lies in the degeneration of the "nobler" parts of the cell consequent on damage to its structure. The result of this damage is to disturb the balance of metabolism by impairing the special functions of the cell, thereby causing persistent overgrowth.

The Research Defence Society has published a pamphlet by Sir Leonard Rogers on "The Value of Experiments on Animals." No one is better qualified than Sir Leonard Rogers to speak with authority on this subject. Investigations on rinderpest in cattle and surra in horses are quoted as examples of the value of animal experiments in the elucidation and prevention of diseases affecting the lower animals, whereby much suffering to the animals themselves and pecuniary loss to their owners are diminished. The action of snake-venoms and the preparation of curative sera for snake-bites, the use of permanganates in the treatment of snake-bite and of cholera, work on the dysenteries, and experiments leading to improved treatments of leprosy, tuberculosis, and kala-azar are all summarised. It is shown how much we are indebted to experiments on animals for a better knowledge of these conditions and for improved methods of dealing with them.

Mr. E. H. Taylor gives (*Philippine Journ. Sci.*, vol. xvi., No. 3, March, 1920) an account of sixty-six species—seventeen being new—of Philippine Amphibia. These belong to the orders Apoda—represented by a new species of Ichthyophis—and Salientia, there being only one doubtful record in the order Caudata. The Salientia, which includes the frogs and toads, is represented by four families, Ranidæ, Engystomidæ, Bufonidæ, and Pelobatidæ, the first of which has by far the largest representation. A new genus of the Ranidæ—Hazelia—is described.

Messrs. Boving and Champlain (Proceedings of the U.S. National Museum, vol. lvii., No. 2323, 1920) describe the morphology and taxonomy of a number of North American species of beetle larvæ belonging to the family Cleridæ. With very few exceptions, these insects, both as larvæ and adults, prey upon destructive wood- and bark-boring beetles. This careful and very exact memoir should appeal to all coleopterists, and the classification of Clerid larvæ illustrates how much a taxonomic arrangement of the beetles can differ from that of their larvæ. A new appropriate classification of larvæ independent of the adults is necessary in this case. The second part of the paper deals with the biology and seasonal history of the Cleridæ. Information of this nature is obviously essential if the forester is ever to benefit by the preservation of the predators, and at the same time by the destruction of the injurious species upon which they prey. The authors state that, whenever practicable, the dissemination of Cleridæ, particularly of Thanasimus and Enoclerus, in quantities in badly infested regions would be a valuable additional aid to control measures.

A certain amount of romance is attached to the control of insect pests by parasites, and the Americans have specialised in this work. Those interested will find a very full illustrated account of the subject in the Monthly Bulletin of the Department of Agriculture for California (vol. ix., No. 4, April, 1920). Several parasites have been introduced as natural enemies of mealy-bugs in the hope that some might prove effective. One, a so-called mealy-bug destroyer, *Cryptolaemus Montrouzieri*, Muls., a ladybird beetle from Australia, was expected to solve the problem, but after the first few months seemed to die out except in particular localities. The reason is fairly obvious. The success of such a parasite means that its natural food becomes scarce, and therefore it starves. The problem has now, however, been solved by the Californian authorities, who found that they could feed the mealy-bug on potato-sprouts, and hence were enabled to keep the ladybird fed and breeding during the winter months. Special insectaries have been built for this purpose, and tubes of the ladybird can be supplied for release when and where necessary the following spring.

Many entomologists will welcome an important paper by Mr. A. C. Baker on the classification of Aphidæ which has been issued lately as Bulletin No. 826 of the U.S. Bureau of Entomology. Probably no group of insects has received more attention from the economic point of view than aphides or plant-lice. Unfortunately, the classification and synonymy of aphides are in a chaotic condition, and great difficulty is often experienced in securing correct naming of specimens. Mr. Baker's paper deals with their generic classification, and was undertaken with the object of remedying this defect, to some extent at least. He regards these insects as constituting the super-family Aphidoidea, and his efforts are confined to the genera and tribes of the family Aphididæ; Phylloxera and its allies he considers to be a separate family. The genus Mindarus is regarded in some respects as the most primitive of all forms, while the Hormaphidini are considered to be the most specialised. The last-named insects are gall-formers; they lack the cornicles or honey-tubes, and have curious aleyrodiform generations. The systematist who desires to make real progress with the specific determination of many aphides will have to rear each individual species and note carefully the characters of each generation for a given food-plant. The labour involved would be great and the time demanded lengthy, but the progress made would be sure, and substantial biological knowledge would result.

The problem of the toxic action of sulphur used as a fungicide is being investigated at the Agricultural and Horticultural Research Station, Long Ashton, Bristol, and a preliminary report on the subject by Messrs. B. T. P. Barker, C. T. Gimingham, and S. P. Wiltshire appears in the station's annual report for 1919, recently received. It has frequently been noticed that flowers of sulphur applied in paste form to the hot-water pipes in greenhouses will keep in check diseases of the mildew type on plants in the houses. Further, there are records of cases of unsprayed gooseberry bushes which have been defoliated as a result of the lime-sulphur spraying of adjacent plots of bushes. The results suggest that the toxicity of the spray is due to some gaseous compound, and if such a compound could be discovered it might be possible to surround plants with an atmosphere sufficiently antiseptic to prevent disease. The nature of the changes which follow the application of a sulphur spray were, therefore, studied, and the results showed that the active agent is the finely divided sulphur which is formed by the decomposition of the spray fluid. Several theories have been advanced to explain the action of this sulphur; the toxicity may be due to the gradual oxidation of the sulphur to sulphur dioxide, to the formation of sulphuretted hydrogen, to conversion into sulphuric acid, or, finally, the sulphur may act of itself by its own vapour. The experiments at Long Ashton show that under ordinary practical conditions none of these hypotheses meet the case. Further experiments have been made, and it is hoped that these will demonstrate the method by which sulphur at a distance from the plants under treatment is brought into contact with the fungus. It then remains to discover what happens when the sulphur comes into contact with the fungus, and for this purpose further researches must be made.

Prof. Jean Massart records (Bull. Acad. Roy. Belgique, Classe des Sciences, 1920, Nos. 4–5) the results of his observations on the movement of different species of littoral flagellates, and gives numerous figures of the organisms and of their paths of movement. Several of the genera and species observed are new, but the systematic descriptions will be published later. In Podomastix (a new genus) the pseudopodia—one to four in number—are long and slender, uniform in thickness, sometimes branched, and movable in an oar-like manner. They are retractile, and represent a transition between pseudopodia and flagella. The two flagella of *Cercobodo primitiva*, n.sp., are tapering prolongations of pseudopodia, but, contrary to those of Podomastix, they are permanent. One of the flagella is anterior and serves for swimming, the other is directed posteriorly. This organism can also move forward by lashing its anterior flagellum, its posterior flagellum and part of its body being applied to some object over which it is progressing, and, finally, it can move in amœboid fashion. The author remarks that many of the flagellates exhibit these three kinds of locomotion. *Clautriavia mobilis*, which has a single flagellum directed backwards, never swims freely; it becomes applied to some object by the flagellum, and pushes itself forwards obliquely, first right, then left. Dimastigamœba, n.g., forms pseudopodia while swimming freely and while creeping. In the latter condition the two flagella trail behind. The reaction —acid or alkaline—of the surrounding fluid was found to play an important part in determining change of form with Eugleninæ. In a slightly acid fluid these organisms swim in a state of extension and without modifying their contour, but if the medium is rendered alkaline the swimming is arrested and the organisms exhibit diverse changes of form.

The latest issue of the Journal of the Marine Biological Association (No. 2, vol. xii.) contains several papers dealing in considerable detail with the life-histories and food of Teleostean fishes. Particularly noticeable is a paper (promising further contributions to the subject) on the physical conditions influencing breeding in marine organisms, breeding being defined as "fertilisation resulting in subsequent development." There is much experimental and observational work in the literature of biology, and Dr. Orton collates and discusses some of this. The breeding of a marine animal is usually seasonal, and may occur during a very limited part of the year, or it may be continuous (in some tropical and abyssal organisms). It may begin at a very early period in the life of an animal, be repeated annually, or even be delayed until almost the end of life, and may occur only once. It is very difficult to correlate the nature and abundance of food with the occurrence and duration of the breeding period, and Dr. Orton inclines to disregard this factor, assigning little or no significance to it. Salinity variations may be so capricious in relation to the distribution and habits of some animals that these, too, are difficult to correlate with spawning cycles. On the other hand, temperature variations seem to explain many facts, and the discussion deals largely with these changes. There is a temperature constant which applies to most marine species, and breeding proceeds when this condition is satisfied. Growth (and absolute dimensions) will depend to some extent upon the fraction of the lifetime of the animal occupied in breeding. One might therefore expect that a semi-sedentary or sedentary animal at the extreme northerly limit of its distribution would be generally larger than one in which the temperature of the sea remained near the constant expressing the temperature optimum. It is suggested that the approximately uniform conditions obtaining in some polar, tropical, and abyssal marine areas may be connected with prolonged, or even continuous, breeding periods. The geographical distribution of a marine animal is obviously controlled by its physiological temperature constant, and deviations from the latter may be the mode of origin of sub-species or varieties.

AMONG a number of water-supply papers issued by the United States Geological Survey special attention may be directed to several series of river plans and profiles constructed in order to determine the location of undeveloped water powers. Recent volumes include "Profile Surveys of Rivers in Wisconsin" (Paper 417), "Profile Surveys of Skagit River Basin, Washington" (Paper 419), and "Profile Surveys along the Rio Grande, Pecos River, and Mora River, New Mexico" (Paper 421). The maps show the outlines of the river-banks, islands, the position of rapids, falls, shoals, and existing dams, and the crossings of all ferries and roads, in addition to the contours of the banks to an elevation high enough to indicate the possibility of using the streams. Data concerning the volume of the flow have been published in previous papers.

THE Monthly Bulletin of the Weather Bureau of the Manila Central Observatory issued by the Government of the Philippine Islands contains detailed observations for numerous stations situated in different parts of the group. The monthly results for August, 1919, are to hand, prepared under the direction of the Rev. José Algué, S.J. Rainfall at Manila during the month was 78·10 in., which breaks all records since the foundation of the observatory in 1865; the previous highest rainfall in August was 43·15 in. in 1877, and the highest for any month of the year was 57·88 in. in September, 1867.

THE exact relations between climate and the growth of crops, and the possibilities of accurate forecasts of production, is the subject of an article by Mr. T. A. Blair in the *Scientific Monthly* for October. Mr. Blair shows in the case of maize in Ohio that the United States Weather Bureau has found that a July rainfall of less than 3 in. means an average yield of 30 bushels per acre, and that a rainfall of 5 in. or more results in 38 bushels. When the July rainfall is 3½ in. the yield is 15,000,000 bushels greater than when it falls short of that amount by half an inch. In the four great maize-growing States of Indiana, Illinois, Iowa, and Missouri the addition of half an inch to a total of 2¾ in. adds 10 bushels per acre to the average yield. A more precise relationship is found in the idea of critical period—that is, certain short periods of time in the growth of any crop, during which its future prospects are largely determined. With some crops this is a single period; with some temperature, and with others rainfall or sunshine, are the most important factors. In the case of maize in Ohio it has been found that the first ten days of August are the critical period as regards rainfall. The application of this knowledge may be used to increase production in two ways. First, it will be possible to determine what crops are climatically suited to a particular district; and, secondly, by the use of early or late varieties and by the help of fertilisers or other means, the crop may be advanced or retarded so as to bring the critical period into coincidence with favourable weather.

Science Progress for October contains an article by Dr. Aston which summaries his work on the atomic weights of the elements as determined by his method of the "mass spectra." These spectra are obtained on a photographic plate placed *in vacuo* by deflecting positive rays on to it by passing them first through an electric, then through a magnetic, field in such a way that all the rays corresponding to an element of given mass are concentrated in a short line on the plate and those of different masses in other parallel lines. The separation of the lines is sufficient to fix the atomic weights to considerably less than a tenth of a unit. By this method it has been possible to demonstrate that boron consists of two, neon, silicon, and chlorine of two or three, bromine of two, krypton of six, and mercury of at least two isotopes—that is, elements of the same chemical properties but of different atomic weights. Dr. Aston concludes that the atoms have weights which are all integral numbers, and that observed fractional atomic weights are due to mixtures of two or more isotopes.

ELECTRIC furnaces in which the heating element consists of a metallic wire or strip are now extensively used both in the workshop and in the laboratory, and possess the advantages of cleanliness, accuracy of temperature control, and small working costs. A special form, possessing several new and useful features, and intended mainly for workshop use, is announced by Automatic and Electric Furnaces, Ltd. The furnace-chamber or muffle is flat on the top and bottom, while the sides are rounded, this shape being specially suited to secure complete contact with the heating coil wound on its exterior. In order to prevent destruction of the coil through inadvertent over-heating, a cut-out consisting of a loop of wire melting at 960° C. is inserted in the furnace. The heating current passes through the loop and is cut off by the melting of the latter, a red pilot-lamp being simultaneously lit up to serve as a warning. Several sizes are listed, ranging in power consumption from 700 to 9500 watts. The muffles are made of a new refractory material called "Ameroid," which is claimed to possess special advantages. We would suggest that intending purchasers of furnaces would prefer to know the composition of the refractory—to which the name given furnishes no clue—so as to judge of its suitability to their requirements.

Engineering for October 15 contains a description of a new 7½-ton six-wheel commercial vehicle made by Messrs. G. Scammell and Nephew, London. One obvious way of reducing costs of road transport is to increase the weight of the load which can be handled by one vehicle and one road crew, and this lorry appears to fulfil this condition admirably. It consists of a four-wheel chassis carrying the engine, and is arranged to draw a two-wheel body which pivots on a turntable at the rear of the chassis. The weight of the complete vehicle is 4½ tons, and it can carry a load of 7½ tons without exceeding an axle-load of 6 tons, which is the limit allowable for a vehicle travelling at 12 miles per hour. The vehicle is able, in addition, to draw a 6-ton trailer, so that a useful load of 13½ tons can be dealt with. Whilst the vehicle is not the first six-wheeler which has been produced, it possesses many points of novelty and interest which add to its usefulness and efficiency. The engine develops 47 brake-horse-power at 1000 revolutimes per minute.

THE presidential address to Section H (Anthropology) of the British Association, which was delivered by Prof. Karl Pearson at Cardiff in August last, has been re-issued as a separate publication by the Cambridge University Press, price 1s. 6d.

Our Astronomical Column.

BRILLIANT METEOR OF OCTOBER 19.—This fine object was observed at 8.15 G.M.T., and descriptions of its appearance have been received by Mr. Denning from Purley and Oxted, in Surrey, and from Stowmarket. Fortunately, the meteor was seen by two experienced observers, Miss A. Grace Cook and Mr. J. Edmund Clark. It was brighter than Venus and gave an intense flash, although the half-illuminated moon was in the same quarter of the sky. The motion was moderate, and a streak remained along one section of the path for about 10 seconds.

On the same date as that on which the meteor appeared the shower of Orionids is usually abundant, and the fireball from its direction of flight seems to have been a brilliant member of that system, though the radiant point was a few degrees below the horizon.

If we adopt a radiant at $88^\circ+17^\circ$, the observations of the object indicate a height from about 61 to 69 miles along a path of 110 miles, and a velocity of about 35 miles per second. In fact, the meteor seems to have been rising in the atmosphere instead of falling, as is usually the case.

The luminous flight occurred over the English Channel, from close to Beachy Head to about 40 miles south of Bournemouth.

Over the West of England the sky was cloudy, and it is important that further accounts should be sent to Mr. Denning from the eastern counties, as the computed heights are rather exceptional and require further investigation.

THE TOTAL SOLAR ECLIPSE OF SEPTEMBER, 1922.—The track of totality in this eclipse traverses the Maldive Archipelago and Christmas Island, south of Java. It then passes right across Australia, but reasonably accessible stations are confined to the eastern portion of its track. Mr. H. A. Hunt, the Commonwealth Meteorologist, acting under instructions from his Government, has prepared a map giving much meteorological information.

A shaded area runs across Australia parallel to, but somewhat south of, the eclipse track; it is stated that this shaded region has no single well-marked wet season, but is subject to both summer and winter rain-producing influences. The map also shows the periods in which most rain falls in each region, and it is noteworthy that the month of September occurs in the wet season on the south coast only, so that the month appears to be favourable on the eclipse track. The sun's altitude on the east coast of Queensland is only 18°, but 26° may be obtained by proceeding inland by rail to Cunnamulla or Coongoola. The directors of the leading Australian observatories have expressed their hope of occupying stations in Queensland, while plans are being formed for expeditions from England to the Maldives and Christmas Island. The scheme of observations will include further verification of the gravitational deflection of light, as it is desirable to strengthen the evidence for a result of such fundamental importance.

THE CAPTURE OF COMETS BY PLANETS.—Prof. H. N. Russell contributes a second article on this subject to *Astr. Journ.*, No. 775. He shows that out of a hundred million comets that approach within an astronomical unit of the sun, 90,000 would be made periodic by Jupiter's action and 2400 by that of Saturn, while the numbers in the case of Uranus and Neptune are only 14 and 8 respectively. Hence he concludes that the two outermost planets have not played any part in such capture, with the possible exception of the comet of the November meteors by Uranus. Prof. Russell admits the curious relationship of the orbits of the comets with periods less than a century, which fall into four groups, the aphelia of which are somewhat outside the orbits of the giant planets. This point gives strong grounds for assuming some connection between these cometary groups and the corresponding planets; further, the point made by Prof. Russell, that many of the cometary orbits considered do not pass within several astronomical units of the planet with which they are associated, may be explained by the slow alteration in the cometary orbit through planetary perturbations.

Many of the facts now pointed out were noted by Mr. R. A. Proctor half a century ago. His explanation was that the origin of the comets in question took place, not by capture, but by expulsion from the giant planets. It is surprising that this suggestion has met with so little support from other astronomers; the phenomena observed in the atmospheres of Jupiter and Saturn testify to the existence of very powerful forces. Even on the earth such explosions as that of Krakatoa occur, in which cubic miles of matter are flung to a great height. Moreover, retrograde orbits would occur more readily if the motion of the parent planet were slower and its gravitation weaker, which would explain their restriction to the comet-families of Uranus and Neptune. Hence it would seem to be premature to accept the non-connection of Neptune with the comet-family that bears his name, as finally demonstrated.

Intensive Cultivation.*

By PROF. FREDERICK KEEBLE, C.B.E., Sc.D., F.R.S.

I PROPOSE to devote my address entirely to horticulture—to speak of its performance during the war and of its immediate prospects. Although that which intensive cultivators accomplished during the war is small in comparison with the great work performed by British agriculturists, nevertheless it is in itself by no means inconsiderable, and is, moreover, significant, and deserves a brief record. That work may have turned, and probably did turn, the scale between scarcity and sufficiency; for, as I am informed, a difference of 10 per cent. in food supplies is enough to convert plenty into dearth. Seen from this point of view, the war-work accomplished by the professional horticulturist—the nurseryman, the florist, the glasshouse cultivator, the fruit-grower and market gardener—and by the professional and amateur gardener and allotment holder assumes a real importance, albeit the sum total of the acres they cultivated is but a fraction of the land which agriculturists put under the plough. As a set-off against the relative smallness of the acreage brought under intensive cultivation for food purposes during the war, it is to be remembered that the yields per acre obtained by intensive cultivators are remarkably high.

The reduction of the acreage under soft fruits—strawberries, raspberries, currants, and gooseberries—which took place during the war gives some measure of the sacrifices—partly voluntary, partly involuntary—made by fruit-growers to the cause of war-food production. The total area under soft fruits was 55,560 acres in 1913, by 1918 it had become 42,415—a decrease of 13,145 acres, or about 24 per cent. But though the public lost in one direction it gained in another, and the reduction of the soft-fruit acreage meant—reckoned in terms of potatoes—an augmentation of supplies to the extent of more than 100,000 tons. Equally notable was the contribution to food production made by the florists and nurserymen in response to our appeals. An indication of their effort is supplied by figures which, as president of the British Florists' Federation, Mr. George Munro—whose invaluable work for food production deserves public recognition—caused to be collected. They relate to the amount of food production undertaken by 100 leading florists and nurserymen. These men put 1075 acres, out of a total of 1775 acres used previously for flower-growing, to the purpose of food production, and they put 142 acres of glass out of a total of 218 acres to like use. I compute that their contribution amounted to considerably more than 12,000 tons of potatoes and 5000 tons of tomatoes.

In this connection the yields of potatoes secured by Germany and this country during the war period are worthy of scrutiny. The pre-war averages were: Germany 42,450,000 tons, United Kingdom 6,950,000 tons; and the figures for 1914 were Germany 41,850,000 tons, United Kingdom 7,476,000 tons. Germany's supreme effort was made in 1915 with a yield of 49,570,000 tons, or about 17 per cent. above the average. In that year our improvement was only half as good as that of Germany, our crop of 7,540,000 tons bettering our average by only 8 per cent. In 1916 weather played havoc with the crops in both countries, but Germany suffered most. The yield fell to 20,550,000 tons, a decrease of more than 50 per cent., whilst our yield was down to 5,469,000 tons, a falling off of only 20 per cent. In the following year Germany could produce no more than 39,500,000 tons, or a 90 per cent. crop, whereas the United Kingdom raised 8,604,000 tons, or about 24 per cent. better than the average. Finally, whereas with respect to the 1918 crop in Germany no figures are available, those for the United Kingdom indicate that the 1917 crop actually exceeded that of 1918. There is much food for thought in these figures, but my immediate purpose in citing them is to claim that of the million and three-quarter tons increase in 1917 and 1918 a goodly proportion must be put to the credit of the intensive cultivator.

I regret that no statistics are available to illustrate the war-time food production by professional and amateur gardeners. That it was great I know, but how great I am unable to say. This, however, I can state: that from the day before the outbreak of hostilities, when, with the late secretary of the Royal Horticultural Society, I started the intensive food-production campaign by urging publicly the autumn sowing of vegetables—a practice both then and now insufficiently followed—the amateur and professional gardeners addressed themselves to the work of producing food with remarkable energy and success. No less remarkable and successful was the work of the old and new allotment holders, so much so indeed that at the time of the armistice there were nearly a million and a half allotment holders cultivating upwards of 125,000 acres of land—an allotment for every five households in England and Wales. It is a pathetic commentary on the Peace that Vienna should find itself obliged to do now what was done here during the war, namely, convert its parks and open spaces into allotments in order to supplement a meagre food-supply.

This brief review of war-time intensive cultivation would be incomplete were it to contain no reference to intensive cultivation by the armies at home and abroad. In 1918 the armies at home cultivated 5869 acres of vegetables. In the summer of that year the camp and other gardens of our armies in France were producing 100 tons of vegetables a day. These gardens yielded in 1918 14,000 tons of vegetables, worth, according to my estimate, a quarter of a million pounds sterling, but worth infinitely more if measured in terms of benefit to the health of the troops.

As the result of Gen. Maude's initiative, the Forces in Mesopotamia became great gardeners, and in 1918 produced 800 tons of vegetables, apart altogether from the large cultivations carried out by his Majesty's Forces in that wonderfully fertile land. In the same year the Forces at Salonika had about 7000 acres under agricultural and horticultural crops, and raised produce which effected a saving of more than 50,000 shipping tons.

Even from this brief record it will, I believe, be conceded that intensive cultivation played a useful and significant part in the war. What, it may be asked, is the part which it is destined to play in the future? So far as I am able to learn, there exist in this country two schools of thought or opinion on the subject of the prospects of intensive cultivation, the optimistic and the pessimistic schools. The former sees visions of large communities of small cultivators colonising the countryside of England, increasing and multiplying both production and themselves, a numerous, prosperous, and happy people and

* From the opening address of the President of Section M (Agriculture) delivered at the Cardiff meeting of the British Association on August 24.

a sure shield in time of war against the menace of submarines and starvation. Those, on the other hand, who take the pessimistic view point to the many examples of smallholders who "plough with pain their native lea and reap the labour of their hands" with remarkably small profit to themselves or to the community.

Before making any attempt to estimate the worth of these rival opinions, it may be observed that the war has brought a large reinforcement of strength to the ranks of the optimists. A contrast of personal experiences illustrates this fact. When in the early days of the war I felt it my duty to consult certain important county officials with the object of securing their support for schemes of intensive food production, I carried away from the conference one conclusion only: that the counties of England were of two kinds, those which were already doing much and were unable therefore to do more, and those which were doing little because there was no more to be done. In spite of this close application of the doctrine of Candide—that all is for the best in the best of all possible worlds—I was able to set up some sort of county horticultural organisation, scrappy, amateurish, but enthusiastic, and the work done by that organisation was, on the average, good; so much so, indeed, that when after the armistice I sought to build up a permanent county horticultural organisation I was met by a changed temper. The schemes which the staff of the Horticultural Division had elaborated as the result of experience during the war were received and adopted with a cordiality which I like to think was evoked no less by the excellence of the schemes themselves than by the promise of liberal financial assistance in their execution. Thus it came about that when the time arrived for me to hand over the Controllership of Horticulture to my successor, almost every county had established a strong county horticultural committee, and the chief counties from the point of view of intensive cultivation had provided themselves with a staff competent to demonstrate not only to cottagers and allotment holders, but also to smallholders and commercial growers, the best methods of intensive cultivation.

By means of county stations the local cultivator may learn how to plant and maintain his fruit plantation and how to crop his vegetable quarters, what stock to run, and what varieties to grow. Farm stations—with the research stations established previously by the Ministry: Long Ashton and East Malling for fruit investigations; the Lea Valley Growers' Association and Rothamsted for investigation of soil problems and pathology; the Imperial College of Science for research in plant physiology, together with a couple of stations, contemplated before the war, for local investigation of vegetable cultivation; an alliance with the Royal Horticultural Society's Research Station at Wisley, and with the John Innes Horticultural Institute for research in genetics; the Ormskirk Potato Trial Station; a Poultry Institute; and, most important of all from the point of view of education, the establishment at Cambridge of a School of Horticulture—constitute a horticultural organisation which, if properly co-ordinated and (dare I say it?) directed, should prove of supreme value to all classes of intensive cultivators. To achieve that result, however, something more than a permissive attitude on the part of the Ministry is required, and in completing the design of it I had hoped also to remain a part of that organisation long enough to assist in securing its functioning as a living, plastic, resourceful, directive force—a horticultural cerebrum. Thus developed, it is my conviction that this instrument is capable of bringing horticulture to a pitch of perfection undreamed of at the present time either in this country or elsewhere.

In my view, horticulture has suffered in the past because the fostering of it was only incidental to the work of the Ministry. In spite of the fact that it had not a little to be grateful for—as, for example, the research stations to which I have referred—horticulture had been regarded rather as an agricultural sideshow than as a thing in itself. My intention, in which I was encouraged by Lord Ernle, Lord Lee, and Sir Daniel Hall, was to peg out on behalf of horticulture a large and valid claim and to work that claim. The conception of horticulture which I entertained was that comprised in the "petite culture" of the French. It included crops and stock, fruit and vegetables, flower and bulb and seed crops, potatoes, and pigs and poultry and bees. I held the view, and still hold it, that the small man's interests cannot be fostered by the big man's care; that horticulture is a thing in itself, and requires constant consideration by horticulturists and not occasional help from agriculturally minded people, however distinguished and capable. I hold that education—sympathetic and systematic—is an instrument the power of which, for our purpose, is scarcely yet tried; is, in fact, of almost infinite potency.

The truth is that great skill and sure knowledge exist among small cultivators side by side with much ignorance and moderate practical ability. Herein lies the opportunity of the kind of education which I have in mind. But for any such intensive system of education to prevail the isolation both of cultivators and of Government Departments must be abolished. There is only one way to prepare the ground for the intensive cultivation of education, and that is to secure the full co-operation of officials and cultivators. If this be not done, the official must continue to bear with resignation the unconcealed hostility of those he wishes to assist. That a state of confidence and co-operation may be established is proved by the record of the Horticultural Advisory Committee which was set up by Lord Ernle during my Controllership. The Committee consisted of representatives of all the many branches of horticulture—fruit-growers, nurserymen, market gardeners, growers under glass, salesmen, researchers, and so forth. That Committee became, as it were, the Deputy-Controller of Horticulture. To it all large questions of policy were referred, and to its disinterested service horticulture owes a great debt. That its existence has been rendered permanent by Lord Lee is of good augury for the future of intensive cultivation.

It may be asked: What are the subjects in which growers require education? To answer that question fully would require an address in itself. Among those subjects, however, mention may be made of a few: the extermination or top-grafting of unthrifty fruit, the proper spacing and pruning of fruit-trees, the use of suitable stocks, systematic orchard-spraying, the use of thrifty varieties of bush fruit and the proper manuring thereof, the choice of varieties suitable to given soils and districts and for early cropping, the better grading and packing of fruit. Of all methods of instruction in this last subject the best is that provided by fruit exhibitions. Those interested in the promotion of British fruit-growing will well remember the object-lesson in good and bad packing provided by the first Eastern Counties Fruit Show, held at Cambridge in 1919. That exhibition, organised by the East Anglian fruit-growers with the assistance of the Horticultural Division of the Ministry of Agriculture, demonstrated three things—first, that fruit of the finest quality is being grown in East Anglia;

secondly, that this district may perhaps become the largest fruit-growing region in England; and, thirdly, that among many growers profound ignorance exists with respect to the preparation of fruit for market.

I believe that no administrator, save the rare genius, can direct the expert, whereas the expert with trained scientific mind and possessed of a fair measure of administrative ability can direct any but a genius for administration. If the work of a Government office is to be and remain purely administrative, no creative capacity is required, and it may be left in the sure and safe and able hands of the trained administrator; but if the work is to be creative it must be under the direction of minds turned as only research can turn them—in the direction of creativeness. To the technically initiated initiation is easy and attractive, to the uninitiated it is difficult and repugnant. The useful work that such a staff as I have indicated would find to do is well-nigh endless. It would become a bureau of information in national horticulture, and the knowledge which it acquired would be of no less use to investigators than to the industry. Diseases ravage our orchards and gardens; some are known to be remediable and yet persist, others require immediate and vigorous team-wise investigation, and yet continue to be investigated by solitary workers or single research institutions. Certain new varieties of some soft fruits are known to be better than the older varieties, and yet the latter continue to be widely cultivated. The transport and distribution of perishable fruit are often inadequate—"making a famine where abundance lies." The information gathered in during the constant survey of the progress of horticulture would serve not only to direct educational effort into useful channels, but to stimulate and assist research.

The tacit assumption which has so far underlain my address is that an extension of intensive cultivation in this country is desirable. I have indicated that areas are to be discovered where soil and climate are favourable to this form of husbandry, and that by the establishment of a proper form of research—administrative—and educational organisation the already high standard reached by intensive cultivators may be surpassed. It remains to inquire whether any large increase in the area under intensive cultivation is, in fact, either desirable or probable.

The dispassionate inquirer will find his task by no means easy. He should, as a preliminary, endeavour to discern in the present welter of cosmic disturbance what are likely to be the economic conditions of the politician's promised land—the new world which was to be created from the travail of war. In the first place, and no matter how academic he may be, he cannot fail to recognise the fact that costs of production, including labour, are at least twice, and probably two and a half times, those of pre-war days, and he must assume that the increase is permanent and not unlikely to augment. What this means to the different forms of cultivation may be judged from the following estimates of capital costs of cultivation of different kinds:

Labour and Capital for Farming and Intensive Cultivation.

—	Labour per 100 acres. Men.	Capital per acre. Pre-war. £	Capital per acre. Present. £
Mixed Farming	3–5	10	20–25
Fruit and vegetable growing	20–30	50	100–125
Intensive cultivation in the open (French gardening)	200	750	1,500–1,875
Cultivation under glass ...	200–300	2,000	4,000–5,000

In the second place, the inquirer is bound to assume that the intensive cultivator of the future, like his predecessor in the past, will have to be prepared to face the competition of the world.

But, on the other hand, he may find some comfort in the fact that both immediately before and, still more, after the war, the standard of living both in this country and throughout the world was, and is still, rising. Hence he may perhaps expect a less severe competition from foreign growers, and also a better market at home. He may also derive comfort from the reflection that the increased cost of production which he must bear must also, perhaps in no less measure, be borne by his foreign competitors. Even before the war the cost of production of one of the chief horticultural crops—apples—was no higher in this country than in that of our main competitors. There are also certain other apparently minor, but really important, reasons for optimism with regard to the prospects of intensive cultivation. Among these is the increasing use of road in lieu of rail transport for the marketing of horticultural produce. The advantages of motor over rail transport for the carriage of perishable produce for relatively short distances—say up to 75 miles from market—lie in its greater punctuality, economy of handling, and elasticity. Fruit crops ripen rapidly and more or less simultaneously throughout a given district. They must be put on the market forthwith or are useless. A train service, no matter how well organised, does not seem able to cope with gluts, and hence it arises that a season of abundance in the country rarely means a like plenty to the consumer. Increasing knowledge of food values, together with the general rise in the standard of living, also present features of good augury to the intensive cultivator. Jam and tomatoes and primeurs may be taken as texts.

In 1914 the consumption of jam in the United Kingdom amounted to about a spoonful a day per person. The more exact figures are 2 oz. per week, or 126,000 tons per annum. It is difficult to estimate the area under jam-fruit—plums, strawberry, raspberry, currants, etc.—required to produce this tonnage, but it may be put at between 10,000 and 20,000 acres. By 1918, thanks to the wisdom of the Army authorities in insisting on a large ration of jam for the troops, and thanks also to the scarcity and quality of margarine, the consumption of jam had more than doubled. From 126,000 tons in 1914 it reached 340,000 tons in 1918. To supply this ration would require the produce of from 25,000 to 50,000 acres of orchard, which in turn would directly employ the labour of, say, from 5000 to 10,000 men. Yet even the tonnage consumed in 1918 allows only a meagre ration of little more than a couple of spoonsful a day. It may therefore be anticipated that if, as is probable, albeit only because of the immanence of margarine, the new-found public taste for jam endures, fruit-growers in this country will find a considerable and profitable extension in supplying this demand.

The remarkable increase in consumption which the tomato has achieved would seem to support this conclusion. Fifty years ago, as Mr. Robbins has mentioned in his paper on "Intensive Cultivation" (*Journal of the Board of Agriculture*, vol. xxv., No. 12, March, 1919), this fruit was all but unused as a food. To-day the production in this country amounts to upwards of 45,000 tons. Yet the demand for tomatoes has increased so rapidly—the appetite growing by what it feeds upon—that the imports in 1913 from the Channel Islands, Holland, France, Portugal, Spain, Canary Islands, and Italy amounted to nearly double the home crop, viz. 80,000 tons, making the total annual consumption not less than 1¼ tons, or about 2 lb. per week per head of population. Is it too fanciful to discern in this rapidly growing increase in the consumption of such accessory foodstuffs as jam and tomatoes, not merely an indication of a general rise in the standard of living and a desire on the part of the community as a whole to share in the luxuries of the rich, but also a sign that in a practical, instinctive, unconscious way the public has discovered simultaneously with the physiologists that a monotonous diet means malnutrition, and that even in a dietetic sense man cannot live by bread alone? If, as I think, the increasing consumption of the accessory foods which intensive cultivation provides represents not merely a craving for luxuries, but an instinctive demand for the so-called accessory food-bodies which are essential to health, then it may be expected that, as has been illustrated in the case of jam and potatoes, consumption will continue to increase. If this be so, the demand both for fresh fruit and also for "primeurs"—early vegetables—should grow, and should be supplied, at least in part, by the intensive cultivators of this country.

If the home producer can place his wares on the market at a price that can compete with imported produce—and it is not improbable that he will be able to do so—he need not, even with increased production, apprehend more loss from lack of demand than he has had to face in the past. Seasonal and other occasional gluts he must, of course, expect.

Even when judged by pre-war values, his market, as indicated by imports, is a capacious one. Thus in 1913 the imports into the United Kingdom of products from small holdings were of the value of about 50,000,000*l.* sterling. To-day it is safe to compute them at more than 100,000,000*l.* To that sum—of 50,000,00*l.*—imported vegetables contributed 5,500,000*l.* sterling, apples 2,250,000*l.*, other fruits nearly 3,000,000*l.*, eggs and poultry more than 10,000,000*l.*, rabbits and rabbit-skins 1,500,000*l.*, and bacon and pork more than 22,000,000*l.* No one whose enthusiasm did not altogether outrun both his discretion and knowledge would suggest that the home producer could supply the whole, or even the greater part, of these commodities. But, on the other hand, few of those who have knowledge of the skill and resources of our intensive cultivators, and of the suitability of favoured parts of this country for intensive cultivation, will doubt that a modest proportion, say, for example, one-fifth, might be produced at home. This on a post-war basis would amount in value to more than 20,000,000*l.*, would require the use of several hundred thousand acres of land, and would provide employment for about 100,000 men.

The estimated acreage under fruit in England and Wales is:

	Acres.
Apples	170,000
Pears	10,000
Plums	17,000
Cherries	10,000
Strawberries	13,000
Raspberries	6,000
Currants and gooseberries ...	22,000
	248,000

exclusive of mixed orchards and plantations.

These figures are, however, well-nigh useless as indicating the areas devoted to the intensive cultivation of fruit for direct consumption. Of the 170,000 acres of apples, cider-fruit probably occupies not less than 100,000, and of this area much ground is cumbered with old and neglected trees. Of the 10,000 acres in pears some 8000 are devoted to perry production, and hence lie outside our immediate preoccupation. Having regard, however, to the reduction of acreage under fruit, to the increasing consumption of fruit and jam, and to the success which has attended intelligent planting in the past, it may be concluded that a good many thousand acres of fruit might be planted in this country with good prospects of success.

Lastly, it remains to consider what results are likely to occur if intensive cultivation comes to be more generally practised in this country.

It may, of course, be true that a chance word, a common soldier, a girl at the door of an inn, have changed, or almost changed, the fate of nations, but it is probable that the genius of peoples and the pressure of economic and social forces are more potent. Is there then, it may be asked, any indication that the people of this country will seek in intensive cultivation a means of colonising their own land rather than continue to export their surplus man-power? The problem is too complex and too subtle for me to solve, but I will conclude by citing a curious fact which may have real significance in indicating that if a nation so wills it may retain its surplus population on the land by adjusting the intensity of its cultivation to the density of its population. If a diagram be made combining the intensity of production of a given crop, *e.g.* the potato, as grown in the chief industrial countries of the world, it will be found that the curve of production coincides closely with that of density of population.

Density of Population and Intensity of Production. Potatoes.

	Density of population square mile.	Percentage of population.	Percentage of yield	Yield in tons per acre less seed. Average 1911–13.
United States	31	10	33	1·3
France	193	62	56	2·2
Germany	311	100	100	3·9
U.K.	374	120	110	4·3
England and Wales ...	550	177	128	5
Belgium	658	212	155	6·04

From these facts we may take comfort, for they indicate that as a population increases so does the intensity of its cultivation: the tide which flows into the towns may be made to ebb again into the country. The rate of return, however, must depend on many factors: the proclivities of peoples, the relative attractiveness of urban and rural life and of life at home and abroad, but ultimately the settlement or non-settlement of the countryside must be determined by the degree of success of the average intensive cultivator. The abler man can command success; whether the man of average ability and industry can achieve it will, I believe, depend ultimately on education. He can look for no assistance in the form of restricted imports. He must be prepared to face open competition. Wherefore he should receive all the help which the State can render; and the measure of success which he, and hence the State, achieves will be determined ultimately by the quality and kind of education which he is able to obtain.

Studies in Animal Inheritance.

ALL students of modern advances in our knowledge of heredity are familiar with Prof. W. E. Castle's experiments in modifying the hooded pattern of piebald rats by continued selection. In a recent Publication of the Carnegie Institution, No. 288, "Studies of Heredity in Rabbits, Rats, and Mice," Prof. Castle describes the results of crossing his selected races with unmodified wild rats, in continuation of his previous work, and announces the conclusion to which he has come. "The same wild race, when its residual heredity is made fully effective by repeated crosses, brings both the *plus*-selected and the *minus*-selected hooded lines to a phenotype of common grade. This shows, contrary to my earlier opinion, that what has really happened in the case of the selected races was more largely due to residual heredity than to any change in the gene for the hooded character itself." In this paper further experiments on the breeding of English and Dutch white-spotted rabbits are also described, the results of which are generally comparable with those obtained from the hooded rats.

The magpie moth (*Abraxas grossulariata*) has been a favourite subject for breeding experiments since Doncaster's memorable demonstration of the sex-linked inheritance of the *lacticolor* colour-aberration. In a recent paper (*Journal of Genetics*, vol. viii., No. 4, 1919) H. Onslow describes the result of crossing with the type the variety *lutea*, in which the ground-colour of the wings is yellow or orange instead of creamy-white, the difference being due to a general deepening of the pigment of the scales. The *lutea* ground-colour is incompletely dominant over that of typical *grossulariata*, so that in the first hybrid generation the colours form a continuous series from white to deep orange, and a plotting of the frequency distribution gives an approximately even "chance" curve. "But the F_2 generation, etc., are at once seen to give curves having more than one maximum caused by the tendency of the colour factors to segregate according to the ordinary Mendelian laws."

In the same number of the *Journal of Genetics* Dr. J. W. W. Harrison continues his series of papers on the hybrid Bistonine moths, dealing especially with what he calls the "stimulus of heterozygosis." His experiments strongly confirm the general belief maintained by Darwin that "cross-fertilisation is a source of strength or of stimulus to metabolic activity"; for he found that among the moths the inheritance of which he studied "the hybrid larvæ were not only emphatically more robust than those of the weaker parent, but they also surpassed in strength and vitality those of the stronger form." Hybrid caterpillars had a very low mortality rate, and they often completed their transformations in an "amazingly short period." Besides discussing the possible intra-cellular causes of these stimuli, Dr. Harrison points out how they may affect the results of breeding experiments on the size and weight factors of such animals as poultry or rabbits. "Any attempted genetic analyses for size purposes which fail to allow for heterozygotic impulses are vitiated and useless."

On the fascinating subject of sex-linked inheritance some new light may come from an extension of Dr. E. Hindle's records of the sexes of series of families of body-lice (*Pediculus humanus corporis*) published in the same number of the *Journal of Genetics*. Three types of family occur, all males, all females, or mixed in which one sex or the other may predominate. The author believes that these results suggest the existence of two types of female and two types of male. The puzzling facts, first noted by Doncaster, respecting coat-colour and sex-inheritance in cats receive further attention and a suggested explanation in a short paper by C. C. Little (*l.c.*, pp. 279–90).

G. H. C.

The Site of the University of London.

WE note with pleasure the decision arrived at by the Senate of the University of London regarding the Government's offer of a site at Bloomsbury. At the meeting of the Senate held on October 20 the report of the Site and Accommodation Committee was adopted, as was also, after a long discussion, the resolution of which we give the full text below. The provisos attached to the acceptance of the offer evince a capacity for keen bargaining and a business mentality not conventionally associated with an academic body. It is to be hoped that they will not in the eyes of the Government constitute an obstacle to the completion of the matter, though it is obvious that some of the conditions will prove difficult in practice. It would be a matter of keen regret if a scheme which has advanced so far should come to grief over any points of detail.

The text of the resolution is as follows:

"That his Majesty's Government be informed that the Senate are prepared to accept the offer made in Mr. Fisher's letter of April 7, 1920, to the Chancellor of the site therein described, gratis and in perpetuity, on the terms as regards the maintenance, rates, etc., of the University headquarters buildings laid down in the Treasury Minutes of February 16 and July 13, 1899, and in Mr. Fisher's letters of June 26, September 24, and October 6, 1920, to the Vice-Chancellor, provided:

"(1) That such grant for maintenance, rates, etc., shall not be counted as a portion of the grants made to universities for educational purposes.

"(2) That the allocation of the site between the various buildings to be erected thereon shall be at the sole discretion of the Senate of the University.

"(3) That the University shall retain and King's College shall retain full possession of their present sites and buildings under the conditions under which they now hold them until such time as the new buildings are ready for occupation and are free from debt.

"(4) That the buildings to be erected for the University headquarters shall be, as regards dimensions and design, in accordance with plans to be agreed upon between the Senate and his Majesty's Treasury, and shall afford not less than 50 per cent. more floor-space than is now allocated in the buildings at South Kensington for the separate use of the University.

"(5) That the terms of the removal of King's College from the Strand to the Bloomsbury site shall be a matter of subsequent negotiation between his Majesty's Government, the Council of King's College, and the Senate of the University, and that an agreement shall be concluded between the said parties.

"And that the Senate, in accepting, subject to the above conditions, the Government's offer of a site in Bloomsbury, assume that the offer does not incidentally involve a policy of curtailing the development of the work of those colleges and schools of the University which are not now, nor in the future will be, situated in the neighbourhood of the Bloomsbury site, and that these institutions will not receive less favourable consideration at the hands of the Government than would otherwise have been the case."

University and Educational Intelligence.

BIRMINGHAM.—At the last meeting of the council profound regret was expressed at the death of Mr. Arthur Godlee, who since 1914 had filled the office of treasurer of the University, and whose death at the present juncture was greatly to be deplored.

The Worcestershire County Council has increased its grant to the University for the current year from 300*l.* to 500*l.*

The following appointments have recently been made:—Mr. T. G. Madgwick, assistant professor in petroleum technology; Mr. Kenneth Neville Moss, assistant professor in coal-mining; Mr. T. Spencer, demonstrator and instructor in petroleum drilling; Miss Nora I. Calderwood and Mr. T. A. Lumsden, assistant lecturers in mathematics; Mr. F. H. Boden, lecturer in machine design; Mr. T. G. Bamford, lecturer in metallurgy; Mr. H. Baker, assistant lecturer in machine design; and Mr. Harold Harris, demonstrator and instructor of assaying.

BRISTOL.—Mr. H. G. Hughes has been appointed assistant lecturer in physics, and Miss G. Gilchrist demonstrator in botany.

The number of full-time day students who have already entered the faculty of engineering this term is 223, as compared with 207 last session.

CAMBRIDGE.—Mr. W. G. Dixon, Downing College, has been re-appointed reader in pharmacology and Mr. S. W. Cole, Trinity College, lecturer in medical chemistry. Mr. T. R. Parsons, Sidney Sussex College, has been re-elected to the Michael Foster research studentship. Field-Marshal Viscount Allenby is to receive an honorary degree on October 29.

Dr. L. E. Shore, St. John's College, and Mr. W. B. Hardy, Gonville and Caius College, have been re-appointed University lecturers in physiology.

The Gedge prize has been awarded to G. E. Briggs, St. John's College, for an essay on "Photosynthesis in Plants."

The Board of Research Studies has recommended to the Senate that degrees of M.Litt. and M.Sc. be established in the University on a two years' post-graduate research course.

EDINBURGH.—The University Court has approved of the minute of the order of the proceedings at the laying of the foundation-stone of the first of the "King's Buildings" by his Majesty the King and the Laureation of her Majesty the Queen on Tuesday, July 6, and directed that it be printed and circulated among the graduates and alumni of the University throughout the Empire and elsewhere, and that an appeal be made for the financial assistance necessary to further the schemes now in progress.

The following appointments have been made to the newly instituted office of reader:—Dr. Cargill G. Knott (applied mathematics), Mr. George G. Chisholm (geography), and Dr. R. Stewart Macdougall (entomology).

The War Office has authorised the utilisation of the estate of Stobs as a forest area in connection with the department of forestry.

LONDON.—A course of three public lectures on "Present Tendencies of Philosophy in America" commences to-day at King's College with a lecture on "New Realism: Its Background and Origin," by Prof. W. P. Montague, professor of philosophy in Columbia University, New York City. The two other lectures will be "New Realism: Its Implication and Promise" (October 29), also by Prof. Montague; and on Monday, November 1, "Pragmatism: Its Right and Left Wings," by Prof. J. E. Boodin, professor in Carleton College, Minnesota. The lectures are at 5.30 p.m., and admission is free without ticket.

Dr. Edwin Deller, assistant secretary of the Royal Society, has been appointed academic registrar of the University in succession to Mr. P. J. Hartog, now Vice-Chancellor of the University of Dacca.

DR. N. MORRIS, assistant to the professor of physiology in the University of Glasgow, has been appointed to the chair of physiology at the Anderson College of Medicine, Glasgow.

A LECTURE on "Eugenics and Religion" is to be delivered at the Wigmore Hall at 5.30 on Tuesday, November 16, by Dean Inge, under the auspices of the Eugenics Education Society.

MR. F. J. HARLOW, head of the department of mathematics and physics at the Sir John Cass Technical Institute, Aldgate, has been appointed principal of the Municipal Technical College, Blackburn, in succession to Dr. R. H. Pickard, now principal of Battersea Polytechnic.

A LECTURE on "Rare Gases in the Atmosphere" will be given by Prof. J. Norman Collie at University College, Gower Street, W.C.1, on Friday, November 19, at 6 p.m., as one of the London County Council's lectures for teachers. The chair will be taken by Mr. A. Chaston Chapman.

A COURSE of twelve free Swiney lectures on geology is announced for delivery by Dr. J. D. Falconer in the geology lecture theatre, Royal School of Mines, South Kensington, on Mondays, Wednesdays, and Fridays, at 5.30, beginning on Monday, November 8. The subject will be "The Modelling of the Earth's Crust."

Societies and Academies.

PARIS.

Academy of Sciences, October 4.—M. Henri Deslandres in the chair.—E. **Picard**: The International Congress of Mathematics at Strasbourg.—The President announced the death of Sir Norman Lockyer, and described the main lines of the scientific work carried out by this distinguished astronomer and correspondant of the Academy.—A. **Lacroix**: A series of alkaline syenitic potassic rocks in sodium minerals from Madagascar.—G. **Bigourdan**: Corrections of the normal time-signals sent out by the Bureau international de l'Heure from January 1 to March 19, 1920. Two types of signal are sent out: ordinary signals for the purposes of navigation, railways, etc., and scientific or rhythmic signals for use in observatories. The corrections for the directing clock are tabulated; those for the time-signals will be given later.—C. **Sauvageau**: The membranes of some algæ (Florideæ) and the setting of the gelosic hydrosol.—M. **Gevrey**: The determination of Green's functions.—T. **Varopoulos**: Some theorems of M. Rémoundos.—J. **Soula**: Generalisation of a theorem of M. Leau relating to the determination of the singular points of a function defined by a Taylor's series.—A. **Bilimovitch**: The intrinsic equations of motion of a solid body.—V. **Vâlcovici**: The hydrodynamical forces in movements differing between themselves by a uniform rotation of space.—J. **Andrade**: The problem of the spiral cylinder.—A. **Vela**: Observations of Nova Cygni. An account of work done on the new star at the Madrid Observatory. Maximum brightness, about 1·4 magnitude, was attained on August 24. A number of spectroscopic observations were made.—J. **Bergengren**: The absorption spectrum of phosphorus for the X-rays.

The substances employed included ammonium phosphate, Bridgemann's black phosphorus, phosphoric acid, and commercial red phosphorus. It was found that the wave-lengths of the limits of absorption were different for the various kinds of phosphorus. This is the first time that the chemical state of an element has been found to have an influence on its X-ray spectrum.—M. **de Broglie** and A. **Dauvillier**: The fine structure of the absorption discontinuities in X-ray spectra. A discussion of some phenomena having a bearing on the results described in the preceding paper by M. Bergengren.—A. **Dauvillier**: The mechanism of the chemical reactions caused by the X-rays. The only mineral substances sensible to the action of the X-rays are crystals for which I. Langmuir, Born and Landé, and Debye and Sherrer have supposed and proved the existence of an ionic structure. All other sensitive substances, colloids, electrolytes, glass, etc., also contain ions. The cause of the chemical actions would thus be due to the destruction of the negative ions, which would lose their electrons under the impact of the rapid electrons constituting the corpuscular radiation. The violet coloration of alkaline glasses, the photo-electric properties of crystals, and the colour-changes in platinocyanide screens are considered from this point of view.—H. **Copaux** and C. **Philips**: The heat of oxidation of beryllium. Direct combustion of the metal in compressed oxygen in the calorimetric bomb gave unsatisfactory results; the combustion of the metal was never complete. The figure required was hence derived indirectly by measuring the heats of solution of the metal and its oxide in dilute hydrofluoric acid. The heat of oxidation, 151·5 calories, was high, and ranges beryllium with calcium (160 calories), lanthanum (148 calories), and magnesium (144 calories).—G. **Denigès**: The microchemical reactions of radium: its differentiation from barium by iodic acid. The usual reagents employed in the microchemical reactions of barium, hydrofluosilicic, oxalic, and tartaric acids, tartar emetic, potassium ferrocyanide, and tartrate give identical results with barium and radium salts. Ammonium cyanurate, ammonium phosphomolybdate in ammonia solution, and potassium bromate, which are also good reagents for barium, give similar crystals with radium compounds. Iodic acid, on the other hand, shows clear differences between the two metals, and reproductions of two microscope-slides are given to prove this. As showing the delicacy of the microchemical method, it is mentioned that all experiments on the reactions of radium were carried out with 0·2 milligram of metallic radium added as the bromide.—R. **Fosse**: The qualitative analysis of cyanic acid.—A. **Lumière** and F. **Perrin**: A new class of hypnotics: the dialkylhomophthalimides. Starting with naphthalene, this is oxidised to phthalonic acid, which reduced by hydriodic acid leads to homophthalic acid, $(CO.OH).C_6H_4.CH_2.CO.OH$, the ammonium salt of which, evaporated to dryness and gently fused, gives the homophthalimide. From this dialkyl derivatives are readily obtained. Used as hypnotics, they possess the advantages of very slight toxic power, and are practically free from unfavourable secondary reactions.—F. **Kerforne**: The tectonic of the Armorican massif.

Books Received.

Die Einsteinsche Relativitätstheorie. By Prof. U. Kopff. Pp. 24. (Leipzig: Greszner und Schramm.) 1.25 marks.

"A New Activity?" A Treatise on Mrs. Dickinson's Discovery of a "New Radio-Activity." By Frank A. Hotblack. Pp. ix+195+plates. (London: Jarrolds, Ltd.) 10s. 6d. net.

Studies in Fossil Botany. By Dr. D. H. Scott. Third edition. Vol. i., Pteridophyta. Pp. xxiii+434. (London: A. and C. Black, Ltd.) 25s. net.

Slide-Rules and How to Use Them. By T. Jackson. Pp. 30. (London: Chapman and Hall, Ltd.) 1s. 6d. net.

Magic in Names and in Other Things. By E. Clodd. Pp. vii+238. (London: Chapman and Hall, Ltd.) 12s. 6d. net.

Œuvres complètes de Christiaan Huygens. Tome Quatorzième. Calcul des Probabilités. Travaux de Mathématiques Pures, 1655–1666. Pp. v+557. (La Haye: M. Nijhoff.)

Practical River and Canal Engineering. By R. C. R. Minikin. Pp. vii+123+xii plates. (London: C. Griffin and Co., Ltd.) 12s. 6d.

Animal Life in South Africa. By S. H. Skaife. Pp. x+281. (Cape Town: T. Maskew Miller; Oxford: B. Blackwell.) 15s. net.

Mechanismus und Physiologie der Geschlechtsbestimmung. By Prof. R. Goldschmidt. Pp. viii+251. (Berlin: Gebrüder Borntraeger.) 32 marks.

Fifteenth Annual Report of the Meteorological Committee to the Lords Commissioners of His Majesty's Treasury for the Year ended March 31, 1920. (Cmd. 958.) Pp. 88. (London: H.M. Stationery Office.) 9d. net.

Electric Switch and Controlling Gear. By Dr. C. C. Garrard. Second edition. Pp. xxii+654. (London: Benn Bros., Ltd.) 25s. net.

Landscape Architecture. By Prof. H. V. Hubbard and T. Kimball. Pp. 132. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press.) 6s. 6d. net.

The Elder Edda and Ancient Scandinavian Drama. By Dr. B. S. Phillpotts. Pp. xi+216. (Cambridge: At the University Press.) 21s. net.

Hittite Seals. By D. G. Hogarth. Pp. xi+108+10 plates. (Oxford: Clarendon Press.) 3l. 13s. 6d. net.

The Flowering Plants of South Africa. Edited by Dr. I. B. Pole Evans. Vol. i., No. 1. (London: L. Reeve and Co., Ltd.) 10s.; hand-coloured plates, 15s.

Relativitätstheorie und Erkenntnis Apriori. By H. Reichenbach. Pp. v+110. (Berlin: J. Springer.) 14 marks.

The Second Danish Pamir Expedition. Conducted by Lt. O. Olufsen. Studies in the Vegetation of Pamir. By O. Paulsen. Pp. ix+132. (Copenhagen: Gyldendalske Boghandel.)

Psychologie du Raisonnement. By E. Rignano. Pp. xi+544. (Paris: F. Alcan.) 18 francs.

The Sun a Habitable Body like the Earth. A Book on Solar Physics. By Sree B. Raha Dass. Pp. xiv+130. (Calcutta: Thacker, Spink and Co.)

Medical Research Council and Department of Scientific and Industrial Research. Reports of the Industrial Fatigue Board. No. 9. A Study of Output in Silk Weaving during the Winter Months. (Textile Series, No. 3.) Pp. 69. (London: H.M. Stationery Office.) 2s. 6d. net.

The Civil Servant and his Profession. A Series of Lectures delivered to the Society of Civil Servants in March, 1920. Pp. viii+124. (London: Sir I. Pitman and Sons, Ltd.) 3s. 6d. net.

The Determination of Hydrogen Ions. By Dr. W. M. Clark. Pp. 317. (Baltimore, Md.: Williams and Wilkins Co.) 5.50 dollars.

The Groundwork of Modern Geography. By Dr. A. Wilmore. Pp. xv+396+xxvii plates. (London: G. Bell and Sons, Ltd.) 6s. net.

A First Course in the Calculus. By Prof. W. P. Milne and G. J. B. Westcott. Part ii.: Trigonometric and Logarithmic Functions of X, etc. With Answers. Pp. xv+181–402+xv–xxxix. (London: G. Bell and Sons, Ltd.) 5s.

Plantation Rubber and the Testing of Rubber. By Dr. G. S. Whitby. Pp. xvi+559+viii plates. (London: Longmans, Green and Co.) 28s. net.

The Centenary Volume of Charles Griffin and Company, Ltd., Publishers, 1820–1920. With Foreword by Lord Moulton. Pp. xx+290+plates. (London: C. Griffin and Co., Ltd.)

Diary of Societies.

THURSDAY, OCTOBER 28.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Dr. M. O. Forster: The Emil Fischer Memorial Lecture.

ABERNETHIAN SOCIETY (at St. Bartholomew's Hospital), at 8.30.—Sir St. Clair Thomson: Recollections of Joseph Lister by one of his House-surgeons.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Sir Thomas Horder: The Treatment of Sub-acute Nephritis by Decapsulation; with an Account of Four Cases.—V. Booney: A New Operation for Nephroptosis.

FRIDAY, OCTOBER 29.

ROYAL GEOGRAPHICAL SOCIETY (at the Æolian Hall), at 5.—T. A. Barns: In the Land of the Okapi and the Gorilla.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Keith: Demonstration on the Contents of the Museum.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. W. Bennett: Winchester: The Cathedral, the School, and the Hospital of St. Cross.

CHEMICAL INDUSTRY CLUB (at 2 Whitehall Court), at 8.—Annual Meeting.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.30.—Dr. A. K. Chalmers: The Function of the Isolation Hospital in a General Scheme of Hospital Provision.

MONDAY, NOVEMBER 1.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. S. G. Shattock: Demonstration of Pathological Specimens in the Museum.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.

INSTITUTE OF BREWING (at Imperial Hotel, Russell Square), at 8.—A. F. Baillie: The Use of Oil Fuel in Breweries.

SOCIETY OF CHEMICAL INDUSTRY (at Institution of Mechanical Engineers), at 8.—Sir William J. Pope: The Photography of Coloured and of Distant Objects.

TUESDAY, NOVEMBER 2.

ROYAL HORTICULTURAL SOCIETY, at 3.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Sir William B. Leishman: An Experimental Investigation of the Parasite of Tick Fever, *Spirochaeta Duttoni* (Horace Dobell Lecture).

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—J. A. Brodie: Presidential Address.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—J. H. Lloyd: Some Observations on the Structure and Life-history of the Common Nematode of the Dogfish (*Scyllium canicula*).—Mrs. O. A. Merritt Hawkes: Observations on the Life-history, Biology, and Genetics of the Lady-bird Beetle, *Adalia bipunctata*, Mulsant.—Hara Ram Mehra: The Sexual Phase in certain Indian Naididæ (Oligochæta).—E. A. Barnes: In the Land of the Gorilla and Okapi.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Capt. C. W. R. Knight: Heronry.

RÖNTGEN SOCIETY, at 8.15.

WEDNESDAY, NOVEMBER 3.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Miss M. E. J. Chandler: The Arctic Flora of the Cam Valley at Barnwell, Cambridge.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—Dr. W. R. Schoeller and E. F. Waterhouse: The Gravimetric Estimation of Bismuth as Phosphate and its applications in Ore Analysis.—P. J. Fryer: The Time Factor in Saponification.—V. Cofman: The Position of Analytical Chemistry in France.—W. T. Burgess: Apparatus for collecting Samples of Water at Great Depths.

THURSDAY, NOVEMBER 4.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Prof. H. Lamb: The Vibrations of an Elastic Plate in Contact with Water.—Prof. H. M. Macdonald: The Transmission of Electric Waves around the Earth's Surface.—Lord Rayleigh: A Re-examination of the Light scattered by Gases in respect of Polarisation. II. Experiments on Helium and Argon.—Prof. C. F. Jenkin: Dilatation and Compressibility of Liquid Carbonic Acid.—W. T. David: Radiation in Explosions of Hydrogen and Air.—Dr. R. E. Slade and G. I. Higson: Photochemical Investigations of the Photographic Plate.—Dr. E. H. Chapman: The Relationship between Pressure and Temperature at the same Level in the Free Atmosphere.—Prof. J. C. McLennan: Note on Vacuum Grating Spectroscopy.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. R. C. B. Wall: Chorea (Bradshaw Lecture).

LINNEAN SOCIETY, at 5.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Wing-Comdr. Flack: The Human Machine in Relation to Flying.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Mrs. S. S. Brierley: Discussion on Vocational Tests.

CHEMICAL SOCIETY, at 8.—L. Higginbotham and H. Stephen: The Preparation of 4-, 5-, and 6-Methyl-coumarin-2-ones, and some Derivatives of *o*-, *m*-, and *p*-Tolyloxyacetic Acids.—H. Stephen: A New Method for the Preparation of 2:4-Dihydroxy- and 2:4:4′-Trihydroxy-benzophenone, and some Observations relating to the Hoesch Reaction.—W. J. Pope and E. E. Turner: Triphenylarsine and Diphenylarsenous Salts.—R. H. Atkinson, C. T. Heycock, and W. J. Pope: The Preparation and Physical Properties of Carbonyl Chloride.—H. W. Bausor, C. S. Gibson, and W. J. Pope: Interaction of Ethylene and Selenium Monochloride.—G. Van B. Gilmour: A Study of the Reactions of Sugars and Polyatomic Alcohols in Boric Acid and Borate Solutions, with Some Analytical Applications.—F. L. Pyman and L. A. Ravald: The Sulphonation of Glyoxalines.—F. L. Pyman and L. A. Ravald; *o*- and *p*-Tolueneazoglyoxalines.—M. E. Laing and J. W. McBain: Investigation of Sodium Oleate Solutions in the Three Physical States of Curd, Gel, and Sol.—J. C. Irvine and E. S. Steele: The Constitution of Polysaccharides. Part I. The Relationship of Inulin to Fructose.—B. E. Hunt: The Preparation of Ethyl Iodide.—R. C. Menzies: Action of Sulphur Trioxide on Aromatic Ethers.—G. T. Morgan and H. D. K. Drew: Researches on Residual Affinity and Co-ordination. Part II. Acetylacetones of Selenium and Tellurium.—R. R. Drew: The Formation of 2:3:6-Trinitrotoluene in the Nitration of Toluene.—J. N. E. Day and J. F. Thorpe: The Formation and Reactions of Imino-compounds. Part XX. The Condensation of Aldehydes with Cyanoacetamide.—O. Becker and J. F. Thorpe: The Formation and Stability of Spiro-compounds. Part III. Spiro-compounds from Cyclopentane.—H. Chattopadhyaya and P. C. Ghosh: Condensation of Dimethyldihydroresorcin with Aromatic Aldehydes.—E. B. Maxted: The Influence of Lead on the Catalytic Activity of Platinum.

FRIDAY, NOVEMBER 5.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science), at 2.30.—Prof. F. W. Oliver: The Reclamation of Waste Land by Botanical Means.—Dr. E. J. Russell: The Reclamation of Waste Land by Agricultural Means.

GEOPHYSICAL COMMITTEE (Royal Astronomical Society), at 5.—Discussion on the African Arc and Meridian, to be opened by Col. H. G. Lyons, and continued by Sir Charles Close, Col. E. M. Jack, A. R. Hinks, C. G. T. McCaw, and others.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Sir Richard T. Glazebrook: Limit Gauging (Thomas Hawksley Lecture).

CONTENTS.

NATURE

THURSDAY, NOVEMBER 4, 1920.

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Symbolic Language of Science.

WE have received from Prof. McAdie, of Blue Hill Observatory, an off-print of a note on the subject of uniformity in aerographic notation, which occupies nine pages (169-177) of the Blue Hill Meteorological Observations, forming vol. lxxxiii., part 4, of the Annals of the Harvard Observatory. It invites agreement with regard to the symbolic representation of the quantities and operations required for the discussion of problems in the dynamics and physics of the atmosphere in pursuance of a suggestion of Dr. Otto Klotz in *Science*, vol. xlvi., p. 360, 1917.

There can scarcely be any difference of opinion as to the desirability of arriving at an agreed practice in the use of symbols by different workers in the same subject. So far as the atmosphere is concerned, Prof. Bigelow held a very comprehensive review of the rank and file of the analysis of atmospheric operations in his discussion of cloud observations which forms the second volume of the Report of the Chief of the Weather Bureau for 1898-99; the first volume of the work on "Dynamic Meteorology and Hydrography," by V. Bjerknes and others (Carnegie Institution of Washington, 1910), sets out the representation of the physical quantities to be employed in a systematic manner, and a book by Mr. L. F. Richardson, now in the printer's hands, ranges over the same field. Ideas of uniformity are naturally developed to some extent in the various parts of the Computer's Handbook of the Meteorological Office, which endeavours to provide the worker in atmospheric dynamics and physics with the necessary material and forms for numerical computation arranged upon a systematic basis, and aspires to attach to each quantity its appropriate symbol.

But the subject bristles with difficulties of many kinds. We have available in practice, let us say, five alphabets ("lower case" roman and italic, "upper case" roman and italic, "lower case" Greek), a few letters taken from other alphabets, and a few additional symbols for units or operations. With these we have to represent the items of a considerable number of quite separate categories; for example, we want to represent: (1) defined quantities for specific units, as m for metre, g for gram; (2) quantities undefined as to unit, as ϕ for latitude and λ for longitude, which may be in radians or degrees, and u, v, w for velocity irrespective of unit; and (3) symbols of operation, as of multiplication, division, summation, and differentiation of various kinds.

In the absence of a sufficiency of letters or alphabets, we are accustomed to make out with suffixes and indices, but here we are liable to get into vexatious difficulties with the printer, and more particularly with the typist, who must be reckoned with in these days, and is apt to display a misguided ingenuity in substituting for a carefully selected symbol the nearest thing to it that can be got out of the keys; and, in any case, if the symbolism could be so arranged as to allow the print to "run on," it would be useful for both reader and publisher.

No adequate account can be given of the details of Prof. McAdie's scheme without reproducing it *in extenso*. With three alphabets and some suffixes and indices (apparently without making any use of the discrimination between roman and italic type), he represents ninety-four quantities, including such modern conceptions as electron, Planck's element of action, Taylor's eddy conductivity and viscosity, and Richardson's turbulivity. He uses them in five pages of fundamental relations. But the allocation is not altogether successful; the letters are all gone, and some very ordinary quantities, such as area and vapour-pressure, have no symbol. N means Avogadro's constant, S entropy, E energy, and W external work; but somehow or other, definition or no definition, N—S and W—E are written down as representing wind components. If it be agreed that kb means kilobar and s means space, there is a certain depravity in using kbs, as Prof. McAdie does, to mean simply a plural of kb.

Furthermore, it is not really possible with our limited number of letters to allocate so many of them for purely arithmetical purposes. Very many of them are wanted for algebra; in fact, many more than are actually available before any allocation takes place. Prof. McAdie allows only x, y, z, and t for co-ordinates, but we must be permitted to change our co-ordinates. In the past, polar co-ordinates, co-ordinates referred to moving axes, and direction cosines have claimed letters which Prof. McAdie proposes to hand over for fixation.

The fact is that the allocation of a letter in common use to one specific and conventional meaning is a very awkward policy. It is not unfair to argue that if we want a symbol to be allocated definitely to a new quantity, and taboo for everything else, we ought to invent a new figure and get it canonised by a sufficient authority to induce printers to stock it. It sounds impracticable, but is at least worth consideration, for meteorologists have already done it in the case of symbols for atmospheric phenomena. Otherwise workers in sciences which are adjacent and not altogether independent are likely to select the same letters for different quantities, and there must be confusion. Perhaps the language of science ought to expand its notation as ordinary language has done by proceeding from single letters to syllables, and that would certainly be an easy and effective way of dealing with the question if we could do away with the convention that multiplication needs no symbol of operation, and require that every operation should be represented by a suitable sign.

Indeed, all ideas of allocating symbols for special quantities lead up to the suggestion that the study of the effectiveness of the language of science ought no longer to be left to the casual play of forces of individual workers. An Academy of Science might with advantage have a literary side, and there might even be lectures on the art of expression, symbolically or otherwise, of scientific truths, with examples, some good and some bad, taken from scientific literature. Scientific institutions tend to separate themselves from the study of the classical languages and become independent centres of learning, and as they do so they ought to make adequate provision for the study of the history and literature of science in order to make sure that the literary form of the results which the institutions will present to the world will not be entirely neglected, as apparently it is now in some contributions to science. Scientific achievement is not really complete when only the author is satisfied with the results. It might be useful to make out how much scientific literature is neglected because its form is crabbed, repulsive, or even unintelligible.

These are quite natural expansions of the idea of economising the effort of the writer and reader by an agreement as to the use of symbols. That is an obvious and essential step, but we ought first to come to an agreement upon some general principles whether, to begin with, there is, or shall be, any difference in meaning between a symbol in roman and the same letter in italic. The Computer's Handbook draws a distinction. It reserves roman for units or symbols of operation. It uses italic to indicate varying quantities, and sometimes capitals for defined quantities. Thus g is gram, but g is gravitational acceleration; θ is temperature, but T is temperature on the absolute scale. Another general question is whether operations should be consistently indicated by letters or by signs, or either mode of indication be allowed as the writer finds convenient.

The difficulty in the way of getting agreement on these questions is not so much unwillingness on the part of workers as lack of authoritative reference to recognised classics. After carrying on an elaborate series of computations with the improvised symbolism that suggests itself as one goes along, it is too laborious to go over it again to bring it into agreement with someone else's notions; and as one is naturally led on gradually in the course of a research to take in more quantities, one can scarcely begin it by selecting a system of notation. It grows of itself as the work progresses. But if the Royal Society were to alternate the list of publications as an advertisement in the lining of its Transactions with a list of recognised symbols, or if in some other way some convention were made quite easy of reference, we should have little difficulty in adhering to it.

NAPIER SHAW.

The History of a Mind.

Pasteur: The History of a Mind. By Prof. Emile Duclaux. Translated by Erwin F. Smith and Florence Hedges. Pp. xxxii+363. (Philadelphia and London: W. B. Saunders Company, 1920.) Price *21s.* net.

PASTEUR has been fortunate in his biographers. There is the well-known life by René Vallery-Radot, which describes for us the man himself, his noble, impulsive character, his thirst for knowledge and zeal for humanity, and gives a general account of his researches and discoveries; an essay by Sir George Newman, which appeared some twenty years ago and deserves republication, expresses in eloquent terms an appreciation of Pasteur's life-work from the English point of view; while, for the purpose of scrutiny of the details of the discoveries themselves, we possess studies by two of the master's disciples, Duclaux and Roux. The volume now under review is a translation by two American pathologists of Emile Duclaux's "Histoire d'un Esprit." In French it is the volume which every serious student of Pasteur's work has read, and it is a little surprising to find, not only that twenty-four years have apparently elapsed before the appearance of an English translation, but also that the original work appears to be almost unknown outside France, according to the senior translator.

The introduction to the book takes mainly the form of a brief memoir of the author. As Boswell derives his fame from Dr. Johnson, and Lockhart is known as the biographer of Scott, so Duclaux will live chiefly in the shadow of Pasteur and by this book. As a chemist, he was first closely associated with Pasteur in 1862 at the École Normale; separated from him for a short time on becoming professor of chemistry at Tours, he was soon transferred to Clermont-Ferrand, where a portion of his time could be given to Pasteur's work; subsequently he went to Lyons as professor of physics for five years, and in 1878 he came to Paris as professor of meteorology in the Agronomic Institute. In 1888, when the Pasteur Institute was founded, Duclaux joined the staff assembled under the command of Pasteur, numbering such illustrious names as Chamberland, Roux, Nocard, Grancher, Metchnikoff, and Yersen among his colleagues. Duclaux's function was the intelligence department, the dissemination of discoveries to the world—not the actual research work. He founded *Les Annales de l'Institut Pasteur*, and in so doing created the channel through which the wealth of the discoveries made by Pasteur and his co-workers poured to the open sea of scientific knowledge. Duclaux was an organiser. He wrote well, with all the vivacity and picturesque style of which a master of the French language is capable; there is not a dull page in his scientific treatises. He found his *métier* as an editor and an interpreter of the labours of others. An ardent toiler, who early adopted Pasteur's motto, "*il faut travailler toujours*," Duclaux himself did little original work. His books, "Ferments et Maladies" (1882) and "Le Microbe et la Maladie" (1885) were records of Pasteur's labours; he collated and co-ordinated the scattered facts on enzymes, classed them into groups according to their reactions, and proposed a scheme of terminology for them. In a word, he was one of the earliest administrators in science. On the death of Pasteur, in 1895, he succeeded him as director of the Institute, and died himself in 1904.

In the book before us, Duclaux traces in detail the steps by which Pasteur was led to make his famous discoveries. "*Que peut bien être l'histoire d'un esprit?*" is the first sentence of the original work, and then the author proceeds to show how, in the hands of Duclaux, the task is possible. Guided by him, we follow Pasteur through the thicket of truth and error. We observe how, amid the storm of criticism and controversy, Pasteur advanced unshaken, and if ever he missed his way for a moment, as in the earlier days of the conflict on spontaneous generation, how speedily and surely he retraced his steps. Duclaux tells us the fascinating story of the first work on crystallography, when the foundations of stereochemistry were well and truly laid. As a chemist, Duclaux lingers over this early work; we can readily understand how great a pure chemist was lost in Pasteur when he chose to become the first bacteriologist. Yet, as Duclaux reveals to us, all Pasteur's life-work pursued an orderly sequence: the study of crystals led to the researches on ferments. "If one of the salts of racemic acid, paratartrate or acetate of ammonia, for instance, is placed in the ordinary conditions of fermentation, the dextro-tartaric acid remains in the liquor, the reason being that the ferment of that fermentation feeds more easily on the right than on the left molecules." Pasteur found then that molecular dissymmetry appeared as a modifying agent on chemical affinities in a physiological phenomenon, and it was a mere step for his mighty intellect to proceed to solve the problems of lactic and alcoholic fermentations, of spontaneous generations, and of the diseases of wines and silkworms. Short, too, was the step again for Pasteur from these studies towards the etiology of microbial diseases, the wonderful work on anthrax and on chicken cholera, the problems of immunity, virulence, and attenuation, and the crowning work on rabies.

All this we read with the avidity of a child for a twice-told tale, and the pen of Duclaux transports us back to the days when these discoveries were revolutionising the realms of medicine and surgery. Sir Rickman Godlee's "Life of Lord Lister" has reminded us afresh of the influence that Pasteur exercised on that great surgeon's work, a debt which Lister acknowledged from the inception of his own researches. Duclaux deals more briefly with the later discoveries of Pasteur, possibly because his own studies had lain more in the direction of the researches on crystallography and fermentations; this, however, is no blemish upon the book, which must always remain a classic in the history of science.

The translation has been faithfully done; at times too faithfully. Thus, on p. 7, "The general law, just now stated, that a science progresses above all by changing its point of view, explains the aid which it always derives from kindred sciences," is too literal a rendering of "La loi générale énoncée tout à l'heure, qu'une science progresse surtout en changeant ses points de vue, explique le secours qu'elle tire toujours des emprunts faits aux sciences ses voisines."

The book is well printed, and illustrated by several portraits of Pasteur at different ages and by two portraits of Duclaux. A good index has been prepared by the translators, who are also responsible for an innovation in a scientific work in respect of a "Who's Who" of persons mentioned in the book. Lister's knighthood is given, but not his peerage.

Duclaux's work thus presented should find new readers both in Great Britain and America.

A. S. M.

Applied Plant Ecology.

Plant Indicators: The Relation of Plant Communities to Process and Practice. By Frederic E. Clements. (Publication No. 290.) Pp. xvi+388+92 plates. (Washington: The Carnegie Institution of Washington, 1920.) Price 7 dollars.

DR. CLEMENTS'S enthusiastic and prolific researches in pure ecology are well known to botanists. In his latest publication he endeavours to apply his principles and methods to the practical problems of agriculture, stock-raising, and forestry, with special reference to the Western United States. According to his view, every plant is an indicator of "conditions, processes, or uses," because it is the product of the conditions under which it grows. The individual, the species, or the community may serve as an indicator, and the choice of the unit to be employed in a given case will depend partly upon the practical end in view, and partly upon the ecological data available. To give a concrete instance: the *species* *Mertensia sibirica* indicates the *condition* "deep shade" in the montane forest of Colorado. In using plant-communities as indicators Dr. Clements relies mainly upon the dominant species, so that in practice there appears to be no sharp distinction between specific and community indicators. His general classification of types of grazing-land, however, is based upon plant-communities, inasmuch as a uniform community of grass, weed, or browse is held to indicate suitability for cattle, sheep, or goats respectively, while a prairie or a grass-scrub mictium [*i.e.* a mixed community containing dominants both from grass- and from scrub-associations] [1] or savannah denotes the advisability of mixed grazing by two or three kinds of animals. As an example of "individual" indicator-criteria, it is stated that ten "water-ecads" [*i.e.* habitat-forms corresponding to ten different degrees of water-supply] of *Ranunculus sceleratus* have been produced experimentally; plate 11 further shows photographs of [natural] shade, alpine, and "normal" ecads of *Campanula rotundifolia, Gentiana amarella,* and *Androsace septentrionalis.*

The nature of plant-indicators, briefly explained above, forms the principal topic of the first section (chaps. i.–iii.), which also deals with the determination and application of indicators, and includes a short historical *résumé* of the indicator concept. Chap. iv. gives a summary review of the climax [*i.e.* climatic] formations of western North America, and, judged by the account of Chapparal-formations—which the reviewer is best able to appreciate from personal knowledge of analogous Mediterranean formations—is adequate on the descriptive side; some useful information regarding rainfall and other environmental factors is included, and the dominant species are recorded for each formation. Altogether this chapter, already outlined in a former paper [F. E. Clements, "Plant Succession," Carnegie Institution, No. 242, 1916], is a very useful addition to the literature of plant geography.

The most interesting portion of the book is the last—roughly one-third of the whole—in which Dr. Clements discusses in detail the practical employment of indicators in the interests of farmers, stock-raisers, and foresters. A striking feature

[1] Words in square brackets are the reviewer's.

of the agricultural section (chap. v.) is the proposal to base the legal classification of land upon indicator communities. The bearing of the study of climatic cycles on agricultural practice is dealt with in the light of facts already for the most part summarised in "Plant Succession." The large amount of space devoted to grazing-indicators (chap. vi., 66 pages) is accounted for partly by the very full discussion of over-grazing, in the detection of which condition indicator-species appear to be specially helpful, and partly by a digression on the general principles of range [ranch] improvement. As regards the forestry section (chap. vii.), the very scant attention paid to afforestation is disappointing to the European reader, though comprehensible in view of the relatively large area of natural forest growth still preserved intact in North America.

In order properly to appreciate Dr. Clements's arguments, it is above all necessary to understand his point of view, which is that of a thorough-going adaptationist who regards every feature in the behaviour or structure of an organism as a response to environment. His utmost concession to the influence of heredity is the admission that "structure also possesses a well-known inertia, as the result of which it may register the impact of factors but partially or slightly." Probably few biologists will be satisfied with so meagre an allowance for the factor of inherited constitution. Further, for Dr. Clements, "ecology is the central and vital part of botany," and other lines of botanical research are, or ought to be, subordinated thereto. One need not, therefore, be surprised to meet with sweeping proposals for the radical reform of taxonomy, involving the institution of a trinomial nomenclature [!] and the virtual abolition of the use of herbarium type-specimens. Unless we are prepared to jettison the taxonomic work of the past centuries in its entirety, it is to be feared that a hasty acceptance of such revolutionary suggestions would increase rather than diminish the difficulties that already beset the taxonomist and all who depend upon him. Doubtless "the practical man is [or would like to be] concerned primarily with real species rather than with the many varieties and forms into which some of them fall"; but the problem of what are "real species" remains to be solved, and surely this desirable end is more likely to be attained through a healthy co-operation among workers in the various branches of biology than by a *tour de force* in any one of them.

Apart from such debatable matter, "Plant Indicators" is a record of a large quantity of solid observation and experiment, and a stimulating book with a wider appeal than that of the average ecological memoir. Judgment as to the practical value of the indicator method must be suspended until it has undergone the test of extensive application under varied conditions and on an economic footing.

Dr. Clements properly lays stress on the special value of ecological research in new or partly settled regions. Oddly enough, no mention is made of those tropical countries which in every respect offer the most promising field to the ecologist, and to which American botanists have unrivalled facility of access. M. D.

The Food Problem of the United States.

The Nation's Food: A Statistical Study of a Physiological and Social Problem. By Prof. Raymond Pearl. Pp. 274. (Philadelphia and London: W. B. Saunders Co., 1920.) Price 16s. net.

ONE result of the Great War has been to bring into unusual prominence the problem of the world's food supply. Each civilised nation contains two great divisions, which in many ways are somewhat antagonistic, dependent respectively on food production and on industrial work. The problem differs in urgency for the two groups: for the food producer, living in the country, it is one of greater or smaller profits, but not of daily bread, of which he is certain; for the industrial town-dweller the problem is more serious, because the intricate social machine is easily thrown out of gear by a few disaffected spirits, and food is forthcoming only so long as the machine turns out sufficient goods to induce the production of more food than the countryman needs for his own consumption.

Prof. Raymond Pearl has given in this book a statistical study of the food problem of the United States, and with his usual thoroughness and breadth of view he has included in his inquiry so many ramifications that his investigation covers Europe also. It thus possesses extraordinary interest at the present time. His tables contain a wealth of material of which only a few indications can be given here. The contribution made by the United States to the food supply of the Allies during the war was remarkable. The pre-war average export of wheat and flour was 122·7 million bushels, of which 43·3 million went to the Western Allies; during the war, but before America's entry, it rose to 262·9 million bushels, of which 151·2 million went to the Allies; even in the first year of the war the Allies still received

114·8 million bushels. This astonishing change is a remarkable achievement for which the Allies may well be grateful and of which America may justly be proud. The total production of food naturally did not increase to the same extent. The data are:—

Total Food Production in the United States: Metric Tons, Millions.

	Total food	Protein	Fat	Carbohydrates	Total Calories, million millions
Average for 7 years, 1911–18	90·2	4·1	5·7	16·3	137·2
,, ,, 3 pre-war years	85·0	3·8	15·5	15·3	129·3
,, ,, war period ..	93·7	4·2	5·9	17·1	143·0

Animals contributed 58 per cent. of the total food, 50 per cent. of the protein, and 83 per cent. of the fat.

The table further shows what a vast amount of food has to be grown in order to produce a sufficiency of nutrients; only 29 per cent. of the total tonnage of human food is net nutrients; the remainder is water, ash, and inedible refuse.

Comparing the annual increases in the production of food with the growth of the population, Prof. Pearl arrives at the comforting conclusion that the food supplies of the United States are increasing more rapidly than the population, so that there is "as yet no occasion for worry along Malthusian lines in this country so far as subsistence is concerned."

Study of the details of Prof. Pearl's tables brings out a number of points of importance to administrators. The very small part played—and playable—by the so-called "home garden" movement is shown by the fact that the *total* vegetable production of farm and garden amounts to only 2 per cent. of the total Calorie production in human food, and of this 2 per cent. a large proportion is contributed by commercial concerns. Similarly, poultry contributes less than 2 per cent. of the Calories. Cows, pigs, and wheat are the great reservoirs, contributing together 62 per cent. of all the protein and carbohydrate used as human food, 69 per cent. of all the fat, and 65 per cent. of all the Calories. Obviously, if there is to be an increase in human food we must concentrate on these (and in England on the sheep as well), and not lose ourselves in less important items, although, on the other hand, we must not fail to develop even a 1 per cent. item.

The distribution of this enormous production is elaborately dealt with. The high-water mark of exports was reached in the year 1914–15; thereafter they fell, and in 1917–18 were down almost to pre-war level; but, of course, the exported food was all going to the Allies instead of being distributed over the world. The 1914–15 result is explained by supposing that all reserves were then cleared out—a process obviously possible once only. In spite of the high exports, more food remained in the United States than in the pre-war period, which may be connected with the larger and more prosperous domestic population.

Finally, a table is given showing the average daily consumption per "adult man." For convenience the British data are also given. The figures are as follows:—

	United States			United Kingdom	Physiologica minimum
	Corrected for waste Grams per day	Not corrected for waste Grams per day		Not corrected for waste Grams per day	Grams per day
Protein ...	114	120	...	113	100
Fat	127	169	...	130	100
Carbobydrate	433	541	...	571	500
Calories ...	3424	4288		4009	3400

The United Kingdom figures are taken from the Royal Society's Report (Cd. 8421), and show that we eat less than our cousins across the water, unless, indeed, we waste less.

E. J. RUSSELL.

Theory of Electric Cables.

The Theory of Electric Cables and Networks. By Dr. Alexander Russell. Second edition. Pp. x+348. (London: Constable and Co., Ltd., 1920.) Price 24*s*. net.

DR. RUSSELL'S well-known book on the theory of electric cables and networks is one which should be increasingly studied as the complex networks, which are now required in connection with large power stations, are constructed. The book is already well known to electrical engineers. It lays down those fundamental principles on which all designs of cable networks must be built up. The kilowatt capacity of central stations for generating electrical energy is now three times as large as it was when the first edition of Dr. Russell's book was published, and the importance of economical design in cables and networks is much more clearly recognised than it was twelve years ago.

The chief difference between the first edition and the second is the introduction of new chapters on alternating current theory and systems of supply, and in the inclusion of numerical examples which will make the book more useful for beginners. Some further extensions of Kelvin's law have been made, and an account is given of recent developments in cable construction. The scope of the work is so well known that it is not necessary to review it in detail. It deals with the properties of conductors and of insulating materials, methods of testing them, and the economy of the various systems of supply. It includes a number of important theorems relating to distributing networks, with the measurement of their insulation resistances and with the determination of the positions of faults.

The subject of dielectric strength is one on which Dr. Russell is a well-known authority, and the chapter on this subject is exceedingly good; it includes a number of useful tables for sparking voltages in air. There is a chapter on the grading and the heating of cables, and another on electrical safety valves, the book concluding with a chapter on lightning conductors. If the theories here given and their practical application were more clearly understood by all central station men, there would be a considerable reduction in the weight of copper which is now laid down in cable systems. It is to be hoped that an increasing amount of consideration will be given to the design of cables and distribution networks, and for this purpose the new edition of Dr. Russell's book will be of great value.

The Carbon Compounds.

A Text-book of Organic Chemistry. By E. de Barry Barnett. Pp. xii + 380. (London: J. and A. Churchill, 1920.) Price 15s. net.

SINCE almost all lecture courses on organic chemistry follow certain main lines, it is to be expected from financial reasons that new text-books on the subject will not diverge far from the older books in their general treatment of the material. All that can be expected from the authors is the infusion of fresh interest by a variation in the scope of the books and in the handling of details. This is to be regretted; but it is apparently almost inevitable.

Within these limitations Mr. Barnett has written an excellent book. It is clearly put, very well illustrated, furnished with formulæ much superior to those usually found in text-books, and in addition possesses certain features distinguishing it from the ordinary run of its class. The most original of these is the guide to the literature of organic chemistry which terminates the introduction, and this is supplemented by references to books at the end of those chapters where further information may be required. By these means the student will gain a truer perspective of the subject, and will not be inclined to assume that his text-book has made him a past-master in the field.

If there is any fault in the book, it lies in the fact that the author appears to over-estimate the mental quickness of the ordinary student. The theoretical side of the subject is dealt with as a whole at the beginning of the volume, and it seems probable that the book would gain considerably if this part of it were extended. Also, cross-references to this section in the body of the text would improve the work.

The commercial applications of organic chemistry are emphasised more frequently than in most text-books, and enough information is given about the heterocyclic section to enable the student to appreciate its importance from the point of view of naturally occurring materials. In a new edition some description of indicators other than phenolphthalein might be given, and possibly a brief reference to the flavones and anthocyanins included in the heterocyclic section.

The book is laudably free from errors, and no misprint in it is likely to give any trouble to a careful reader. The only important slip appears to be the erroneous formula for chloropicrin given on p. 150.

As a whole the book is marked by its fresh treatment of the material, and is to be welcomed. Its main drawback lies in its price.

A. W. S

Our Bookshelf.

Anthropology and History: Being the Twenty-second Robert Boyle Lecture, delivered before the Oxford University Junior Scientific Club on June 9, 1920. By Dr. W. McDougall. Pp. 25. (London: Humphrey Milford; Oxford University Press, 1920.) Price 2s. net.

THE object of this instructive lecture is to illustrate the importance of the study of anthropology as an adjunct to the study of history. Anthropology is not exclusively concerned with the measuring of skulls, or with the study of primitive man, save for the sake of cultured man. Without it, it is impossible to understand the causes of the rise and fall of nations, to forecast their future, or to guide the statesman from the experience of the past. An alien culture can rarely be imposed upon a people by external power and authority. As examples of the effect of race upon culture, the lecturer points to the disappearance of Buddhism from India and its progress in Tibet and China; the relative distribution of the Roman Catholic and Protestant forms of Christianity in Europe; and the power of expansion as illustrated by the success of Great Britain and the failure of France to create a colonial empire. These last, capacity and incapacity, were evolved in the prehistoric period, because no adequate explanation of them in the historical period can be postulated, and similar diverse qualities are assigned by the earliest historians to the ancestral stocks of both peoples.

The races capable of producing and sustaining civilisation at a high level are generally formed from the blending of several peoples of superior natural endowments, when social institutions are free from the feeling of caste. This last condition is important, because the concentration of natural endowments in a privileged order inevitably leads to atrophy and decline. Men and nations are both free to choose and pursue their course towards higher ends, and anthropology, studied as a branch of history, will suggest the means by which this progress can be attained.

The Journal of the Institute of Metals. Vol. xxiii., No. 1, 1920. Edited by G. Shaw Scott. Pp. xii + 644 + xxx plates. (London: The Institute of Metals, 1920.) Price 31*s*. 6*d*. net.

THE large size of this volume, as compared with that of previous issues, is an indication of the growing interest in the metallurgy of the non-ferrous metals. Sir George Goodwin's presidential address demonstrates the importance of those metals to the Navy, an importance which would in itself justify the existence of the institute. The fifth report to the Corrosion Committee carries this valuable investigation a stage further, and succeeds in throwing light on the problem of the corrosion of condenser tubes, the new facts concerning the skin on the surface of a drawn tube being of distinct value to the discussion of the possible methods of lessening corrosion. A similar subject is dealt with in a paper by Dr. Seligman and Mr. Williams on the action of hard waters on aluminium. Mr. Vivian's paper on the alloys of tin and phosphorus is an excellent piece of thermal analysis, dealing with a system of which one component is highly volatile, thus introducing great experimental difficulties. The alloys of zinc with less than 15 per cent. of aluminium and copper respectively are described in a paper from the National Physical Laboratory, and Dr. Haughton, of that laboratory, also contributes a preliminary account of the investigation of alloys by determination of the thermo-electromotive force. Some remarkable results obtained a few years ago by Mr. Alkins in the drawing of copper wire, which indicated a discontinuous change of properties at a certain stage of reduction, are now confirmed by very careful further experiments. The results contained in another paper in the same volume, on the properties of rolled copper, make it clear that rolling affects the metal much more irregularly than drawing, so that definite conclusions are not easily reached. Other subjects dealt with are the casting of brass of high tensile strength, and the production of idiomorphic crystals of copper.

C. H. D.

Dead Towns and Living Men: Being Pages from an Antiquary's Notebook. By C. L. Woolley. Pp. viii + 259. (London: Oxford University Press, 1920.) Price 12*s*. 6*d*. net.

THIS is a lively account of a digger's life on ancient sites, mainly describing hobnobbing with Kurds and other amiable ruffians, or bluffing Turkish officials, revolver in hand. The methods may have been effective, but could scarcely be a settled mode of living. The first half of the title is rather neglected, as there is but little archæology, and only five views of Carchemish, which is the bait of the book. A dozen pages give a welcome account of the remains of the Hittite capital, of which as yet only a small part has been opened. The complete clearance of this capital of a scarcely known civilisation will take years to finish. When done, there are several other cities one beneath another, and the clearance of each of them will mean the removal of everything of later age. Obviously there should be a museum to hold all the Hittite sculptures, and the site bared to study the cities beneath, which descend 30 ft. below the level of four thousand years ago.

A different point of interest is the sketch of Egyptian mentality (pp. 39–44) when natives imagine that fine buildings are known, and offer to show them. This is a painfully frequent failing; here the view is taken that this is auto-suggestion really believed in, and capable of being extended to the minds of other people, who all become convinced of what does not exist. If we can take this view it will, perhaps, explain the Indian conjuring feats as being such suggestion on the minds of spectators. Can it also be the true view of the sights well known in Egypt, of men holding red-hot iron in the hands or mouth, which show no trace of blistering or burning after it? Is there a power of suggestion to compel hallucination on cool English observers? It is at least as likely as a power of resisting burns.

A Manual of Practical Anatomy: A Guide to the Dissection of the Human Body. By Prof. Thomas Walmsley. With a Preface by Prof. Thomas H. Bryce. In three parts. Part i., *The Upper and Lower Limbs.* Pp. viii + 176. (London: Longmans, Green, and Co., 1920.) Price 9*s*. net.

PROF. WALMSLEY, in this manual, ranges himself with those teachers of anatomy who think that the subject should be studied almost exclusively in the dissecting-room, and that the student should be encouraged to build up his knowledge of the subject from personal observations. In his text, therefore, the author confines himself to the description of what any average student can readily discover for himself, and in his illustrations to simple line drawings such as any average student can easily reconstruct and supplement. The purely descriptive parts are also everywhere subordinate to the instructions which are given as to the manner of dissection and as to what may be observed in the actual process of dissection. The text is singularly accurate for a first edition, but certain of the diagrams are not quite so satisfactory. In Fig. 2 the cutaneous nerves of the back (cervical region) are in excess; in Fig. 4 the median part of the front of the leg is not shown supplied by cutaneous nerves; in Fig. 7 the formation of the median nerve takes place on the median side of the axillary artery; in Fig. 13 the coraco-brachialis muscle is shown on the median side of the musculo-cutaneous nerve; and in Fig. 51 the outer head of the musculus accessorius is omitted. These matters can be readily amended in any further edition, and scarcely detract from the value of the book, which in its length and simplicity is a not inadequate *riposte* to the larger and more elaborate manuals.

W. W.

Splendours of the Sky. By Isabel Martin Lewis. Pp. vii+343. (London: John Murray, 1920.) Price 8s. net.

THIS book can be warmly recommended to readers who desire to obtain a popular non-technical summary of the advances made in physical astronomy in the present century. The author's position as a computer for the American Nautical Almanac ensures an accurate knowledge of geometrical astronomy and of problems relating to distances and motions; and she writes in an enthusiastic tone that evinces a deep admiration for the "splendours of the sky."

The planets are reviewed in order. In discussing the vexed question of the rotation of Venus the author's judgment leans to the twenty-four-hour value, which implies a physical condition not unlike that on the earth. Prof. W. H. Pickering's explanation of the Martian canals as being due to the deposition of moisture by storms following fairly definite tracks is favoured as the most plausible one, but Lowell's irrigation theory is also described.

The remarkable solar work accomplished at Mount Wilson comes next, including the study of the sun's magnetic field, vortices round sunspots, and the recently named "hydrogen bombs." There is also mention of Einstein's prediction of the gravitational deflection of light, and the preparations made to test it at the eclipse of 1919. But the book went to press before the results were available.

The chapters on the stars include such recent work as Dr. Shapley's determination of the distances of clusters. It is necessary to criticise the suggestion on p. 247 that the M and N types are alternative routes to extinction. The galactic concentration of the N stars is proof of great distance and high luminosity; they are therefore giants, not dwarfs. A protest must be made against the use of the words "billion," "trillion," etc., in the American sense in a work published in London. An international agreement on the meaning of these terms would be welcome.

A. C. D. CROMMELIN.

Peetikay: An Essay towards the Abolition of Spelling: Being a Sequel to "Some Questions of Phonetic Theory," part i., 1916. By Dr. Wilfrid Perrett. Pp. 96. (Cambridge: W. Heffer and Sons, Ltd., 1920.) Price 6s. net.

IT is refreshing to find nowadays a scholarly essay written in a style so attractive as to engage the interest of even a casual reader. Dr. Perrett, in his quest for a land free from the horrors of orthography, is a hearty knight, who will merrily break a lance, if not a crown, with any pedant who comes along. He will have none of your "reformed" spelling, which is but one more shuffle of the historic pack of twenty-six letters among some forty sounds. He does not want to reform spelling indifferently well, so he creates a new alphabet, which is called "Peetikay," a word composed of his three first consonants and three first vowels. The basis of his vowel notation is the pitch of the whispered vowel, and he evolves a system of characters which are "real," giving at once some indication of both vowel quality and vowel length. His classification of consonant sounds starts from the voiceless mutes "p, t, k," being arranged finally in order of their place of formation. Particularly interesting, and frequently provocative of discussion, are his remarks upon the English sounds "h" and "r."

By means of his new notation Dr. Perrett aims at a just correspondence between signs visible and signs audible, so that English writing shall be English language in counterfeit. It is a book full of learning, well seasoned with humour, and brimming over with originality; it is a powerful blow at those who bleat about "vulgarity, degeneracy, and corruption of English," and an earnest appeal for "less professorism, and a little more shrewd insight and informed, constructive teaching."

A. LL. J.

A History of English Philosophy. By Prof. W. R. Sorley. Pp. xvi+380. (Cambridge: At the University Press, 1920.) Price 20s. net.

IN this very useful and handy volume we are given, in chronological order, a short record and brief epitome of the men of British birth who have a claim to be remembered on account of their philosophical writings. It begins with the medieval scholastics who wrote in Latin, and whose British birth is merely of biographical interest, and it ends with writers several of whom are still living, and among whom the author of this book is himself entitled to take rank. The attempt, however, to present this succession of British-born philosophers as a history of, or as material for a history of, English philosophy is not, and in the nature of the case cannot be, a success. In the history of philosophy English philosophy has denoted two distinct movements at definite periods. In the eighteenth century it denoted, throughout the intellectual world, the system of Newton and the principle of Locke. At the end of the nineteenth century English philosophy meant the evolution theory of Charles Darwin and the method of Herbert Spencer. In this book Newton and Darwin are mentioned as having given a direction to philosophy, but they are given no place among the philosophers. On the other hand, William Gilbert (quite rightly) is included, but this makes the omission of the two former only the more remarkable.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Light Produced by Rubbing Quartz Pebbles Together.

I HOPE that the letter from Lieut.-Comdr. Damant in NATURE of October 21 may induce some chemist to endeavour to ascertain the cause of the peculiar "empyreumatic" odour which accompanies the flashes of light produced by rubbing two quartz pebbles one against the other. My attention was first directed to the fact that the flashing could be obtained, as well when the pebbles are rubbed together submerged in a basin of water as in air, by the Rev. Reginald Gatty.

I have ascertained that careful chemical cleaning of the surface of the pebbles does not prevent the production of the peculiar smell—which might have been due to a deposit of organic matter from the sea—on pebbles picked up on the seashore. I also have ascertained that bits of quartz from inland quarries give out the peculiar smell when they are rubbed together so as to produce flashes of light, and the same smell accompanies the light production when large crystals of rock-crystal are used. Further, I found that the light flashes can be produced when the quartz or crystal is submerged in alcohol. Probably other liquids would not arrest it. Consequently it should be possible to obtain the volatile odoriferous matter in solution when produced and to subject it to chemical examination. It would not be difficult to devise a little mechanism for producing flashes of light by grinding two quartzite pebbles together beneath a small quantity of liquid for some minutes, or even hours, and so to obtain in the liquid such emanations from the triturated quartz as are soluble in suitable liquid reagents. (See pp. 60–61 of my "Diversions of a Naturalist," Methuen, 1915.)

E. RAY LANKESTER.

October 31.

Chemical Warfare, the Universities, and Scientific Workers.

I HAVE just received an invitation from the War Office "to become an associate member of the Committee now being constituted as part of the new peace organisation for chemical warfare research and experiment." The invitation was accompanied by what is stated to be the present list of associate members, containing more than sixty names well known in science. As it stands, this list is certainly a very powerful inducement to accept the invitation in the case of anyone content in this important matter to follow the lead of his more influential colleagues, for it comprises a very large proportion of the best known workers in the branch of science mainly involved. Unfortunately, however, it includes my own name, and I take it, therefore, that, in part at least, it is in reality a list of those to whom invitations are being issued rather than of those who have accepted the invitation.

The function of the Committee is stated to be "the development to the utmost extent of both the offensive and defensive aspects of chemical warfare." Its work is governed, as regards disclosures, by the terms of the Official Secrets Act, and every member of the Committee will be required to sign a statement that he has read the Act and is prepared to abide by its provisions. It is the intention to allocate, so far as practicable, research of a purely scientific nature in chemical warfare to universities and similar outside institutions.

Now, for my part, I think this is a very important matter which ought not to be left entirely to the personal choice of individuals, but should be most carefully considered by the universities and by scientific workers as corporate bodies. It was one thing for scientific men and the universities to be called upon in the stress of actual conflict to assist the fighting Services when they were forced by enemy action to protect themselves against, and in turn to develop, a mode of warfare until then proscribed by civilised nations, but it is surely quite another matter for them, in consequence, to be called upon without consultation to become a normal part of the peace organisation for developing it in secret, both in its offensive and defensive aspects, to the utmost possible extent.

I do not think there is any precedent for this departure. Universities train medical men indiscriminately for civil and military services, but the Army Medical Service is non-combatant, and is intended to ameliorate the horrors of war. Universities of late have recognised military subjects in their curricula for their diplomas, and lent their organisations for the purposes of what were in origin defensive military services, such as the Volunteer and Officers Training Corps.

Personally, I feel that universities and scientific men stand for something in the world higher than anything which has as yet found expression and representation in Governments, particularly in their international relations. In consequence, I fear that they will find themselves in a false position if they allow themselves by default to be depressed to the position of mere agents to develop this new and, as yet, still unlegalised mode of warfare. The uses likely to be made of their work are, in the present unsettled condition of the world, highly uncertain, except in so far as it is quite certain that the effective control over these uses is not the part in which they are invited to co-operate. No one can pretend that scientific organisations are strong enough to dictate, as in the case of the professional medical organisation, the purposes for which science shall be used in the community. My own individual view is against accepting this invitation until the question of the position of the universities and scientific men as corporate bodies, in the part of the organisation which they are not invited to join, has first been satisfactorily settled. I think the properly constituted unions of scientific workers should give the matter their consideration and lay down for the guidance of their members the conditions under which they should, if at all, accept the invitation. It would be most helpful to have the views of my colleagues, particularly of some of the sixty-four who are stated already to have joined the organisation as associate members, publicly expressed upon this very important matter.

FREDERICK SODDY.

British Laboratory and Scientific Glassware.

THE British glass industry is undoubtedly to be congratulated on attaining the excellent results described in Mr. Jenkinson's letter in NATURE of October 28, but I may venture to point out that it is little comfort to the user to know that good glass is made if no guidance is given him as to the particular brand referred to. Of the five samples tested it is true that the best was British, but the worst was also British. I gather from inquiries made that the faults complained of by laboratory workers are not so much defective resistance to alkalis, etc., but insufficient annealing and liability to break with changes of temperature. Table glass is well annealed, so that the defect in question is not insuperable, and a want of care in the manufacture is suggested. The increased loss by breakage has become a serious consideration in the running of practical classes since British glass has been in use. As pointed out in previous correspondence, the danger of restricting import lies in the lack of inducement to further improvement.

W. M. BAYLISS.

University College, London.

THE points raised by Mr. Jenkinson in his letter on the subject of laboratory and scientific glassware published in NATURE of October 28 should direct the attention of users of such glassware to the quality of the British-made product as compared with other well-know Continental brands.

No single type of glass can be superior to all others for all purposes. One glass may be superior as regards attack by water and acids, but inferior in respect to attack by alkaline solutions. As it would obviously be highly inconvenient in practice for chemists to use different types of glass for different reactions, a general average must be taken, and a study of the papers in the Journal of the Society of Glass Technology referred to by Mr. Jenkinson will convince any unbiassed person that the quality of British laboratory glass has been proved fully equal, if not superior, to that of any other laboratory glass from whatever source it may have been obtained.

In the earlier days of the war complaints were frequently heard as to the finish of British-made articles. Either they were too thin, too thick, uneven, or the colour and shape were unsatisfactory, etc. Whilst these complaints were frequently justified, they were chiefly due to lack of experience. The blowing of laboratory glassware of the desired thickness and even throughout requires considerable experience on the part of the glass-blower, and blowers trained in this branch of the industry were not available. The glass used in the manufacture of laboratory ware is much harder (less fusible and with a shorter viscosity range) than that to which the blowers were accustomed, and this militated against the rapid acquirement of the technical skill necessary to produce the best class of ware.

The hardness of the glass and the undesirability of using fining agents such as arsenic and antimony rendered it very difficult to obtain the molten glass homogeneous and free from small gas-bubbles, and necessitated increased furnace temperatures during melting, thus calling for alterations in the design of furnaces in use or the erection of new furnaces of special type.

The colour of British laboratory glass is admittedly inferior to that of the best foreign glass. This is due to the purity of the materials used, particularly the sand. British sands can be obtained with nearly the same degree of freedom from iron as the best Continental sands, but not in considerable quantity or of constant quality. For special purposes, where freedom from colour is essential—*e.g.* Nessler cylinders—specially selected qualities of British sands may be used, or even imported sands, but from the general point of view of the chemical and scientific glassware industry it is absolutely essential that we should be able to produce highly efficient laboratory ware without recourse to the importation of any material from outside the Empire, and so far as possible with only British materials.

Further experiment and experience both with materials and melting operations will undoubtedly lead to improvement in the appearance of the product, and we claim that as British manufacturers, with the aid of British men of science, we have mastered the difficulties attendant on the production of the necessary quality of glass so successfully. They will, given fair opportunity, master the less essential, but nevertheless desirable, property of pleasing appearance.

Scientific apparatus, particularly lamp-blown apparatus, has received a considerable amount of attention from manufacturers and men of science interested in the technology of the glass industry.

It is a fact, unfortunately, that in pre-war days the best work of this class was done by German and Austrian lamp-workers. This work is now carried on largely in this country (to a considerable extent by disabled soldiers and sailors), and great progress has been, and continues to be, made. Research work on the most suitable types of glass tubing for lamp-working purposes has been carried out with very successful results (Journal of the Society of Glass Technology, 1917, vol. i., p. 61; 1918, vol. ii., pp. 90, 154).

Manufacturers have followed up suggestions for possible improvement, sometimes with success and sometimes otherwise, but generally associated with considerable trouble and expense, and we may fairly claim that great improvement has been achieved in this direction, and that few grounds for legitimate complaint remain on the score of the annealing of British-made laboratory ware.

A further and most important section calls for mention, namely, the production of graduated apparatus. To some extent this is a factory operation, but the production of accurate and trustworthy graduated apparatus calls in addition for the most highly skilled, careful, and experienced work and supervision. The work entailed is much greater than appears on the surface. Experimental work has been carried out at the National Physical Laboratory and at Sheffield University, and the testing department of the National Physical Laboratory has drawn up stringent regulations for the certifying of first-class graduated apparatus, so that such apparatus with the National Physical Laboratory certificate of accuracy can be relied upon to be quite as trustworthy as the well-known German apparatus with the Reichsanstalt certificate.

Complaints and unfavourable comparisons have frequently been made in connection with British laboratory ware, and very few expressions of appreciation or gratitude to those manufacturers who stepped into the breach to supply an absolutely indispensable article, knowing that their productions were far from perfect, but striving, with the help of the best scientific aid in the country, to improve the quality of their ware. Very great progress has been made, but under the abnormal conditions ruling at present in this country it is essential that stability should be assured for some time to come until the industry has had time to settle down from what is practically an experimental stage to normal working conditions.

Is it conceivable that the research work done by Sir Herbert Jackson, Prof. Turner, the National Physical Laboratory, and others, and the patient and frequently thankless efforts of manufacturers to render this country independent in such an essentially key industry, should be wasted; and that the valuable experience already gained should be lost on account of the flooding of the English market with Continental productions—made so easy by the present rate of exchange between England and Germany—and the consequent transference of our energies to less essential, but certainly more lucrative, directions?

FRANK WOOD.

(Wood Bros. Glass Co., Ltd.)

Borough Flint Glass Works, Barnsley,
November 2.

Crystal Growth and Recrystallisation in Metals.

THE effects of heat on certain cast and plastically deformed metals have been studied in considerable detail by Prof. H. C. H. Carpenter and Miss C. F. Elam in an investigation which was published and discussed at the autumn meeting of the Institute of Metals held at Barrow-in-Furness under the presidency of Vice-Admiral Sir George Goodwin.

At the outset the authors state that the terms "recrystallisation" and "crystal growth," which signify quite different phenomena, have previously been used for the most part indiscriminately and interchangeably, with the result that the discussion of this subject has necessarily been confused and unsatisfactory. By "recrystallisation" is meant the complete reorientation of a crystal or group of crystals. The new arrangement starts from new centres, and is quite independent of the old system of orientation. It is, in fact, the birth of new, differently oriented crystals in a crystal aggregate, and the gradual change of the old to conform with the new. This always gives, in the first instance, a refined structure. When all trace of the old arrangement has disappeared it is considered that recrystallisation is complete. By crystal growth is meant the rearrangement of certain crystals in a crystal aggregate to conform with the orientation of certain other crystals, during which process the latter increase in size by the addition of reoriented material at the same time as the former decrease in size by the same amount. This process necessarily leads to an increase in crystal size.

Many of the authors' experiments have been carried out with an alloy of tin and antimony containing about 1·5 per cent. of the latter metal. This alloy possesses a very peculiar property, which makes it of special value for investigating the above phenomena, and for the first time has enabled the stages of crystal growth in a metallic complex to be studied experimentally. It presented, however, some special difficulties in polishing and etching. Cutting, filing, and even grinding on the finer emery papers bring about spontaneous recrystallisation of the surface layer. This entirely obscures the genuine structure of the specimen, and can be removed only by alternate polishing and etching. Ammonium sulphide solution is the best reagent for developing the structure, and by alternately immersing the specimen in the solution and rubbing it on selvyt or chamois leather with magnesia moistened with ammonium sulphide a very beautiful surface is obtained. This reagent attacks different crystals to very different degrees, so that some appear white, and others black, under the microscope. This proved of considerable assistance in the experiments, as it made it easy to identify a particular area under examination. If a polished and etched specimen was heated at 150°–200° C., and growth of any of the crystals took place, the position of the new boundary was marked by a line which is really a difference of level almost as if the specimen had been etched; but there was no visible change in the surface of the reoriented area.

That these lines represent the position of the new boundaries after heating could be shown by (1) taking a photograph of an area which included some of them; (2) repolishing and re-etching the specimen and rephotographing the same area. On comparing the two photographs the boundaries of the crystals as shown by the etching in (2) correspond exactly with the new lines in (1). It was always a simple matter to distinguish between a growing crystal and one that was being grown into. The alloy tarnishes on heating, being first yellow, then orange, red, purple, blue, and green in turn. Just as the crystals etch differently, so they tarnish differently; but they tarnish first in accordance with the original etch. There is always a colour contrast between adjacent crystals, and the colour fixes the original boundaries. If new boundaries appear *inside* this colour boundary, it shows that the adjacent crystal is growing into it; if *outside*, it shows that the crystal is growing into its neighbour.

A very remarkable feature about these boundary markings is that they are formed only when the specimen is removed from the furnace and cooled. If a specimen is heated and cooled three times, there will be three new boundaries round some of the crystals; if four times, there will be four, and so on. But if another specimen be heated along with the first, and taken out only when the former was removed for the fourth time, one new boundary marking alone would be visible. It is, therefore, an arrest in the progress of growth which makes these markings on the surface, and further heating does not obliterate them. There is, however, no sign of them after polishing and etching, only the final and genuine crystal boundary being then visible.

The authors publish numerous photographs illustrating these phenomena, and the accompanying series revealing the gradual decrease in size and final disappearance of a crystal in four stages is taken from a plate in their paper. The crystals concerned are represented by letters in Fig. 1. Fig. 2 shows the effect of heating once. The crystal A has been invaded by crystals C, D, and E. Crystal C continues to grow on further heating, and also crystal B to a small extent (Figs. 3 and 4). The state of things after heating four times is shown in Fig. 5. All four crystals have invaded A, and C and E have met. Fig. 6 is of the same area repolished and re-etched, and shows that A no longer exists. The orientations of crystals B, C, and D as revealed by the etching are very different from that of A. It is possible that the orientations of A and E do not differ greatly, yet each crystal has taken a considerable share of A.

From a large number of observations the authors have drawn the following conclusions: (1) Crystal growth always took place by gradual

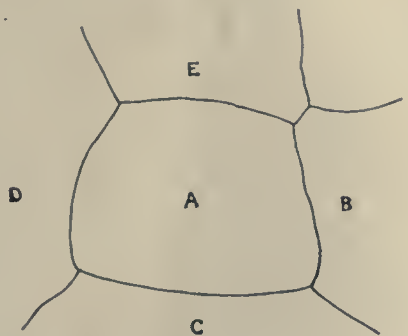


FIG. 1.

FIG. 2.—1st heat.

FIG. 3.—2nd heat.

FIG. 4.—3rd heat.

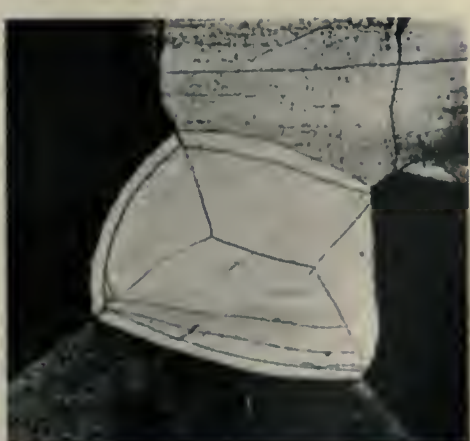


FIG. 5.—4th heat.

FIG. 6.—Same as Fig. 5, repolished and re-etched.

Magnification 100 diams. Reduced by one-sixth.

boundary migration, and not by coalescence; (2) growth may take place either of a large crystal into a small one, or of a small into a large—*i.e.* crystal growth does not depend on the relative size of crystals; (3) the relative orientations of the crystal which is being grown into and that which is growing do not appear to affect growth; (4) a crystal which is itself being invaded by one crystal may grow at the same time at the expense of another; (5) the change of orientation is accompanied by a difference in level of the surface which is the boundary usually observed; (6) the rate of growth is not constant for any given time at a particular temperature.

The authors tested the generally accepted view that the crystals of castings do not grow upon heating. This view, although widely held, does not rest upon adequate experimental evidence, and the difficulty of finding a suitable method of testing it is considerable. In the first place, all forms of strain in cutting, grinding, and polishing a specimen must be avoided, because it is known that work will produce recrystallisation of a metal on annealing. The ordinary methods of preparing a metal surface for microscopic examination are quite sufficient to cause recrystallisation of the surface layer on annealing, particularly in soft metals. After experimenting with various methods, the one finally adopted was suggested by the well-known fact that impurities tend to lie in the crystal boundaries of castings, whereas in the worked or annealed metal they either pass into solution or remain scattered throughout the crystals quite independent of the boundaries. It was reasoned that if it could be shown that after prolonged annealing the boundaries coincided with the impurities, it might be considered evidence that they were in the same position after annealing as before. The impurities must be such that they are insoluble in the metal and have a high melting point. Exhaustive tests were carried out with the metal aluminium, which, even in its purest form, contains the compound $FeAl_3$. In the cast metal some of this compound is always found existing in the boundaries. The authors publish a photograph showing that, even after annealing for ten weeks at 550° C., the boundaries of the crystals are still outlined by the impurities, and since the latter cannot have moved, it follows that neither have the boundaries. A specimen of rolled aluminium annealed for the same period showed that, except in a very few cases, the boundaries were quite free from impurities. The authors conclude, then, that the cast metal when free from strain showed neither crystal growth nor recrystallisation on subsequent heating.

The latter part of the investigation deals with an elaborate study of the quantitative effects of deformation on crystal growth and recrystallisation, and the structural changes produced in a crystal aggregate by deformation followed by heat may be summarised somewhat in the following way:—

The first effects are slight. They are revealed by slip bands, and in some cases by twins. The former are completely, and the latter to some extent, removed by heating. No change is observed in the shape of the crystals. The boundaries appear unaffected, and, apart from the twins, there is no change in orientation. Thus far only the interior of the crystals is affected. No identities are lost. Somewhat greater deformation, however, produces crystal growth, and at this stage the boundaries of the crystals become active. The activity is shown in the capacity of the growing crystal to push forward its boundary in certain directions, thereby invading other crystals, but even at this stage the orientation of the growing crystals is maintained. That of the crystals grown into is, of course, destroyed, unless it happens to be the same. The third stage, produced by still greater deformation, appears to take place exclusively in the boundaries of deformed crystals. It is here that the new crystals are born, indicating the destruction of the original crystals and a complete change of orientation. Whereas, therefore, the early effects of deformation are manifest in the interior of the crystals, the later ones appear to take place entirely at the boundaries.

The chief facts established by these experiments are: (1) The largest crystals are always formed after the minimum amount of stress sufficient to produce growth, which minimum is determined by the annealing temperature; (2) the lower the temperature the greater the stress required to produce the large crystals; (3) there is no gradual increase in size from the original-sized crystals up to the largest which form directly from them.

It is considered that all the evidence brought forward points to plastic deformation followed by heat as the true cause of crystal growth and recrystallisation followed by crystal growth. The only exception to this is where an alteration of crystal form occurs when a metal passes through a phase change. Apart from the direct evidence against any growth of crystals in castings, confirmatory evidence of the following nature has been obtained in this research: (1) Growth and recrystallisation can be induced by work; (2) the size of the crystals produced on heating at a given temperature after work is entirely dependent on the amount of deformation; (3) there is always in practice a limit to the crystal growth produced by work and heat in any metal as a result of which a single crystal has not yet been produced by prolonged heating. Such a result, however, is theoretically imaginable, provided that the degree of deformation and subsequent temperature of heating could be adjusted to certain very precise conditions.

Whatever forms of energy operate during the growth or recrystallisation of a crystal on heating, the authors' conclusion is that the energy is imparted to the metal when it is deformed. That energy cannot be stored in the amorphous vitreous films, which, according to Sir George Beilby, are the cause of work-hardening in metals, because, as the authors have shown, the growth of crystals in a worked metal proceeds after all mechanical softening has taken place. Hence all the amorphous metal must have recrystallised. It is, moreover, difficult to explain why the least deformation should produce the largest crystals on heating if growth depends on the presence of amorphous metal. Further, the energy cannot be stored in the amorphous cement around the crystals as conceived by Rosenhain, because (1) all the available evidence is against the view that the crystals of castings grow; (2) the greater the surface area of a crystal the more energy it should possess, and on this view a large crystal should absorb a small one. It has been shown that this is by no means always the case. It is considered that until much fuller knowledge of the structure and properties of crystals has been obtained, the true explanation of the effects of work upon metals will not be forthcoming.

The New Star in Cygnus.

By MAJOR W. J. S. LOCKYER.

THE new star in Cygnus, the third discovered in that constellation, and therefore designated Nova Cygni III., was of magnitude 3·5 when first observed by Mr. Denning on August 20, but is now very faint, being below 9th magnitude. It is still visible in small telescopes, but requires large instruments for spectroscopic investigation.

A summary of the earlier part of the star's history—*i.e.* previous to August 20—is brought together by Mr. Felix de Ray in the current issue of the *Observatory* (vol. xliii., No. 557, October), and is of great interest. Thus the object was not visible on June 3, 1905, when a plate taken of that region showed stars down to the 16th magnitude. On July 20 of the present year another plate taken there recorded stars down to magnitude 11; but still there was no trace of the nova. A photograph taken at Harvard on August 9, 1920, shows stars to the 9th magnitude, and no nova appears upon it; but the object was recorded there on August 19, and its magnitude was then 4·8. An earlier record than this is given on a plate taken by Nils Tamm in Sweden on August 16 of this year, when it was shown as a 7th-magnitude star.

The above records give an idea of the nature of the rise in magnitude of the nova, and these data (broken lines), combined with the excellent series of observations made at Greenwich (continuous lines), and published in the same number of the *Observatory* (p. 367), enable the light curve of the nova to be constructed. This curve is given in Fig. 1. It will be seen that, like all novæ, there is a very rapid rise to maximum brilliancy, followed for a short period by an almost as rapid decrease. After that the decrease is more gradual, but at a quicker rate than is generally the case in later stages of novæ.

It should be remarked that the Greenwich values here recorded are "smoothed" values—that is, a mean curve has been drawn through the original observed values. This process has the drawback of eliminating any small oscillations of magnitude which may occur in the original curve. Thus on the descending side of the curve there are undoubtedly instances where the nova not merely retained the same magnitude for two consecutive nights, but actually increased in brightness. Such fluctuations were, however, on a very small scale, and nothing like the pronounced regular variations which Nova Persei presented after it had reached the 4th magnitude, the amplitude of this fluctuation amounting to about one and a half magnitudes in periods of three or four days.

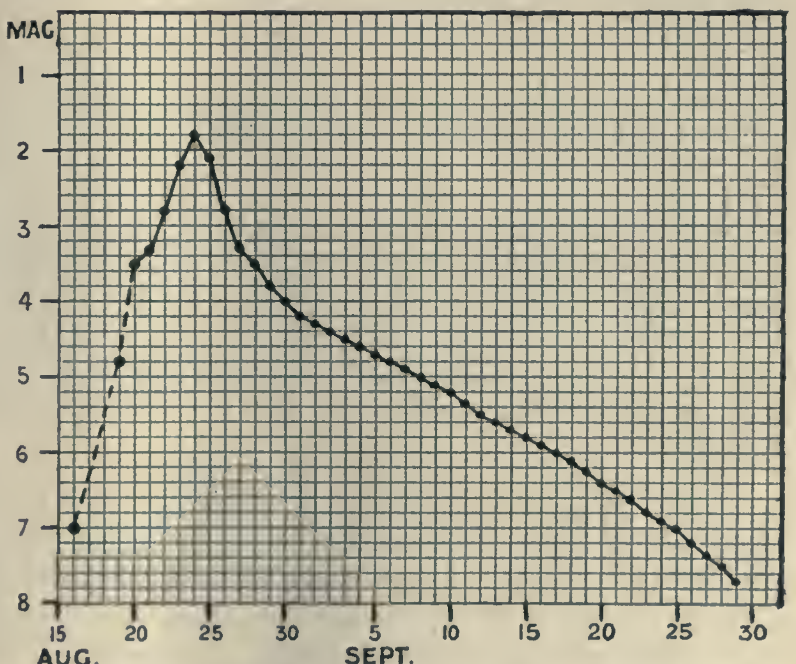


FIG. 1.—The light curve of Nova Cygni III., illustrating the rapid rise to maximum and the comparatively slow descent. The unbroken line is from observations made at Greenwich Observatory.

No less interesting has been the spectroscopic study of this nova. Up to the present time very little has been published on the subject, but no doubt several communications upon it will be made at the November meeting of the Royal Astronomical Society. In Section A of the British Association at the recent meeting Prof. Fowler showed some slides taken from negatives secured at the Hill Observatory, Sidmouth, on the night of August 22, when the nova was approaching its maximum.

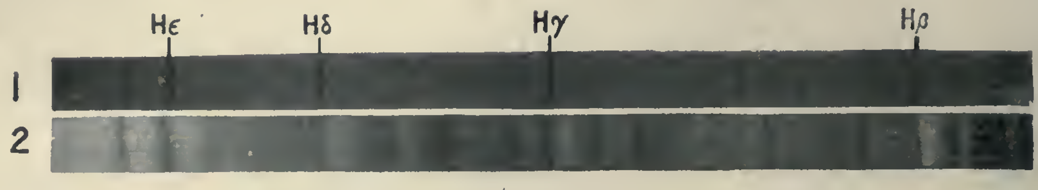
These photographs showed that the spectrum was practically identical with that of the star α Cygni—that is, it was practically an absorption spectrum. This star is noted for exhibiting fine, sharp lines representing metals at a very high temperature, these lines being enhanced when passing from the temperature of the arc to that of the spark. Two nights afterwards, when the nova attained its maximum brilliancy, all the lines became broad and fuzzy, and bright components to the lines began to show up at the red end of the spectrum. More recent work at the Hill Observatory has shown that at later stages all lines became more diffuse, a larger number of bright components appeared, and the continuous spectrum began to dim.

The stage when the nova showed a *typical* nova spectrum is illustrated in Fig. 2. It will be noticed that amongst others all the dark hydrogen lines have bright components on the right-hand side. For the sake of comparison, a spectrum of the star α Cygni is placed above the nova spectrum, and the line Hβ is made to fit the dark Hβ in the nova.

The reason why the other hydrogen lines in α Cygni do not fit those in the nova is that, owing to the great velocity in the nova, these lines are displaced towards the left—*i.e.* towards the violet. From measurements made, the velocity in the line of sight works out at about 400 to 900 km. per sec., depending on the date on which the photograph was taken. In this particular case—namely, August 26—the velocity was about 900 km. per sec., and was actually the maximum velocity attained.

At a late stage in their career novæ begin to exhibit the nebular lines. The first indication of this stage having been reached in the present nova was recorded on a photograph taken at the Hill Observatory, Sidmouth, on October 22. The stage might have been reached at possibly an earlier date, but no records were available between October 2 and the date mentioned above.

As a rule, new stars are far more scarce than comets, but Mr. Felix de Ray points out the interesting fact that for a couple of years novæ have been more plentiful than comets, and that at the present time no fewer than four novæ, including Nova Aquilæ III., Nova Lyræ, and Nova Ophiuchi IV., can be observed with small apertures.



1. α Cygni. 2. Nova Cygni, August 26.

FIG. 2.—The spectrum of Nova Cygni on August 26, showing the *typical* nova spectrum. The comparison spectrum is that of α Cygni, which the nova closely resembled on August 22.

Obituary.

DR. HERMANN STRUVE.

DR. KARL HERMANN STRUVE, who died on August 12 at the age of sixty-six, belonged to a family famous in astronomy, being the son of Otto Struve, and the grandson of F. G. W. Struve. All three were gold medallists of the Royal Astronomical Society, this being a unique case of hereditary distinction in the annals of that body.

K. H. Struve was born at Pulkova in 1854, being the third of the four sons of Otto Struve, who was then director of Pulkova Observatory. He studied at Dorpat University, where he showed special aptitude in physics and optics. Apparently it was the acquisition of the 30-in. refractor at Pulkova that tempted him to devote his life to astronomy. It was with this instrument that he made the splendid series of observations of Saturn's satellites for which his name will be chiefly remembered. He adopted the plan of comparing the satellites with each other, instead of with Saturn, which led to a great increase in accuracy. His discussion of the observations gave greatly improved values of the masses of primary, ring, and satellites, and of the positions of Saturn's equator and the orbit planes; it also revealed some interesting librations in longitude. For this work Struve was awarded the R.A.S. medal and the Damoiseau prize of the Paris Academy. A similar investigation on the system of Mars gave the position of Mars's equator, the amount of its oblateness, and the rate of motion of the nodes.

Other astronomical work included double-star measures, star parallaxes, micrometer measures of Eros, and drawings of Jupiter; moreover, in 1874 Struve took part in the Russian expedition to Port Possiet, Eastern Asia, to observe the transit of Venus.

In 1895 Struve became professor of astronomy at Königsberg, and director of the observatory, for which he obtained a 32·5-cm. refractor. In 1904 he succeeded Dr. W. Foerster as director of the Berlin-Babelsberg Observatory, retaining this post until his death. So late as 1916 he made further observations on Saturn's satellites with the 26-in. refractor there. He suffered for some time from heart trouble, and his death was probably accelerated by a bad fall last spring. He married in 1885, and leaves a son and daughter.

ALFRED LIONEL LEWIS.

WE regret to record the death of Mr. Alfred Lionel Lewis on October 22. Mr. Lewis, who was in his seventy-ninth year, joined the Anthropological Society of London in 1866, and was elected a member of its council in 1869. When the society was absorbed by the foundation of the Anthropological Institute in 1871, Mr. Lewis became a member of this body, of which at the time of his death he was one of the oldest members. He was elected a member of the council in 1876, and in 1886 he became treasurer, an office which he continued to hold for seventeen years. From 1905 to 1907 he served as vice-president. Mr. Lewis's interests were directed almost exclusively to archæology, and in particular to megalithic monuments, a subject on which he was for many years recognised, especially in France, as one of the foremost authorities. The great accuracy of his measured plans and drawings was not the least valuable feature in the numerous papers on this subject which he contributed to the Proceedings of the Anthropological Institute, the Prehistoric Congresses of France, the International Congresses on Prehistoric Archæology, the International Congress of Religions, and the British Association. He had already attained the fiftieth year of his membership of the last-named body, and had looked forward eagerly to taking part in 1921 in the celebration of the jubilee of the Royal Anthropological Institute.

THE death is announced, at the age of seventy-five, of DR. ANTON WEICHSELBAUM, emeritus professor of pathological anatomy in the University of Vienna. Soon after graduation, Weichselbaum became interested in pathology, and published work on the nature of rheumatoid arthritis. Before long he turned his attention to the then young science of bacteriology, and investigated the cause of pneumonia. About 1886, after a detailed investigation of a number of cases of this disease, he published a paper in which he described a coccus, the *Diplococcus pneumoniae*, as the causative organism, which corresponded with the organism previously described by Fraenkel. In 1887 his *magnum opus* appeared, on the discovery and description of the causal organism of cerebrospinal fever, the *Diplococcus intracellularis*, which is now almost universally accepted as the causative organism of this disease. In 1885 Weichselbaum succeeded Rokitansky in the chair of pathological anatomy, remaining on the active staff of the university until last year, when he was appointed emeritus professor. In 1912 he was installed as Rector Magnificus for the year, the highest honour in the gift of the university. Weichselbaum was a great investigator and a teacher of repute. In addition to numerous original papers and communications, he was the author of "Elements of Pathological Histology," which was translated into English.

THE death of MR. WILLIAM MELVILLE is recorded in *Engineering* for October 29 as having occurred on October 21. Mr. Melville was born in 1850, and served his pupilage with the North British Railway Co., under Mr. James Bell. He joined the Glasgow and South-Western Railway in 1874, and rose to be engineer-in-chief of the company, a position from which he retired in 1916. Mr. Melville was responsible for a large number of extensions and improvements on the railways and docks in Scotland, among which may be mentioned the widening of the City Union lines, Glasgow, which comprised the demolition of the old viaduct carrying the railway over the Clyde, and the substitution therefor of a new viaduct carrying four lines on the site of the old viaduct. He also extended St. Enoch Station, Glasgow, adding six new platforms to the six of the original station.

Notes.

WE are glad to note that a movement is on foot to establish a memorial to the late Mr. W. Duddell, whose early death in November, 1917, deprived many of a valued friend and cut short a career of scientific research of great brilliance. Mr. Duddell's work on the recording of the wave-form of alternating currents, including the development of the oscillograph, had great influence on alternating current theory as well as on telephony, while his well-known researches on the electric arc led up to a large field of development in wireless telegraphy. The memorial is to take the form of a medal to be awarded periodically by the council of the Physical Society at its discretion to those who have advanced physical knowledge by the invention or design of scientific instruments or of materials used in their construction. If sufficient funds are available, it is also proposed to form a fund to be devoted to the foundation of scholarships or prizes to be awarded to students of the Physical Society under conditions to be determined by the council. We are sure that the many friends whom Mr. Duddell made among the members of the Institution of Electrical Engineers and of the Röntgen Society, of both of which he had been president, and of the Physical Society, of which he was for some years the treasurer, will be glad of the opportunity to support the scheme. An influential committee has been formed under the chairmanship of Sir William Bragg (president of the Physical Society). Mr. R. S. Whipple (president of the Optical Society) is acting as hon. secretary to the Duddell Memorial Fund, and subscriptions may be sent to him at 15 Creighton Avenue, Muswell Hill, N.10.

WITH the advice and assistance of the National Research Council of the United States, a co-operating group of scientific investigators of insect pests and plant diseases, together with representatives of leading industrial concerns engaged in the manufacture of chemicals and appliances used in fighting these enemies of crops, has been organised under the name of the Crop Protection Institute. This institute will undertake and support a series of thorough scientific studies of the crop pests themselves and of the means for improving and standardising the materials and appliances used in fighting them. The Board of Trustees of the institute is composed of nine scientific men representing leading organisations interested in crop protection and four representatives of the manufacturing and commercial interests. The temporary secretary is Mr. Harrison E. Howe, chairman of the Division of Research Extension of the National Research Council. The annual losses as a result of the attacks on growing and stored crops by insect pests and plant diseases are enormous, despite all that has been done to lessen them. A conservative estimate of the loss of wheat in the United States in a single recent year on account of the black-stem rust is 180,000,000 bushels, and this pest is but one of many that attack the wheat every year.

THE Federal Government of Australia, acting in response to representations which have been made to it, has taken steps for the preservation of the aborigines who are under its jurisdiction. It has been decided to set aside part of the State lands in the Northern Territories as a reservation for the tribes. This aboriginal reserve will include the Mann and Petersen Ranges and practically the whole of Lake Amadeus. Areas have also been set aside by the Governments of South and Western Australia in the adjoining districts for the purpose of this reserve. No intimation has been received that medical attention will be provided, but it is to be hoped that, if no step in this direction has been taken, some form of medical service may be instituted, as it is essential to the success of any scheme to preserve the aboriginal from extinction.

THE presidential address delivered by Sir Robert Hadfield to the ninth annual conference of the British Commercial Gas Association at Sheffield on October 19 has now been published. The address deals with a number of problems connected with increased production and with the economy of natural resources. True economy does not consist in the mere cutting down of expenditure; wise expenditure on improved working conditions, on modern plant, on research, and on education is more than ever necessary. Increased production demands economy of fuel, diminished cost per unit of production, and the better organisation and training of labour by scientific planning and direction of the details of operations. This would be accompanied by a decrease of strain on the workers rather than by an increase, owing to the elimination of unnecessarily fatiguing methods and the extension of the use of labour-saving machinery. The universal adoption of modern methods of obtaining heat and power would result in cheaper factory construction, economy of space, increased speed and trustworthiness of output, and decreased consumption of fuel. Tables are given to show the present state of the national industries, and also to compare gas, coal, and electric heating from the point of view of cost and consumption of coal in the heating and melting of steel. It is evident that for heating to moderate temperatures coal is the cheapest fuel; whilst for melting, producer gas is by far the most economical. Electric energy cannot compete with gas in cost, except for certain classes of work at very high temperatures. The author again directs attention to the necessity of applying scientific principles more thoroughly to the design of furnaces, and urges the desirability of a study of the important researches of Groume-Grjimailo on the flow of heated gases through a furnace.

THE Carnegie Corporation of New York some time ago made a gift of five million dollars to the American National Research Council and National Academy of Sciences, of which about one million dollars is to be devoted to the erection of a building in Washington to serve as the home of these two closely related scientific organisations. The remainder of the total sum is to serve as an endowment for the maintenance of the Council. A site for the building, comprising an entire block of land near the present Lincoln Memorial in Potomac Park, has just been obtained at a cost of about 200,000 dollars through gifts from about a score of generous individuals, most of whom are business men associated with great industrial concerns or generally interested in the promotion of American science. The National Research Council, which was organised during the war to aid the Government in mobilising the scientific resources of America, in both *personnel* and material, for attack on scientific problems connected with America's war-time activities, has now been reorganised on a peace-time basis as a permanent institution for the promotion of scientific research and the dissemination of scientific information. It is not a Government Department or Bureau, but is privately supported and wholly controlled by the co-operating scientific men of the country. The major part of its membership is composed of appointed representatives of about forty American major scientific and technical societies. Dr. George E. Hale, director of the Mount Wilson Solar Observatory, is the honorary chairman, and Dr. H. A. Bumstead, professor of physics at Yale University, is the active chairman for the present year. Dr. Vernon Kellogg, formerly of Stanford University, is the permanent secretary.

THE Institut International d'Anthropologie has been formally constituted, with a provisional council of direction, consisting of representatives of seventeen nationalities.

MR. ALAN A. CAMPBELL SWINTON, chairman of the council of the Royal Society of Arts, will deliver the inaugural address of the 167th session on Wednesday, November 17, at 8 p.m. His subject will be "Wireless Telegraphy and Telephony."

THE annual general meeting of the National Union of Scientific Workers is to be held at King's College, Strand, on Saturday, November 13, at 2.30. An invitation to attend is extended to all scientific workers. The annual dinner of the union will take place in the evening of the same day.

THE Stockholm correspondent of the *Morning Post* announces that the Nobel prize in medicine for 1919 has been awarded to Dr. Jules Bordet, chief of the Pasteur Institute, Brussels, and the same prize for 1920 to Prof. August Krogh, professor of physiology in the University of Copenhagen.

THE PRINCE OF MONACO has summoned a meeting of representatives of the Oceanographic Section of the International Union of Geodesy and Geophysics for January 25, 1921, at Paris. An extensive programme of the work to be undertaken by the Section will be submitted to this meeting.

A DISCUSSION on the African arc and meridian will be held in the rooms of the Royal Astronomical Society on Friday, November 5, at 5 p.m. The chair will be taken by Col. E. H. Hills. Col. H. G. Lyons will open the discussion, which will be continued by Sir Charles Close, Col. E. M. Jack, Mr. A. R. Hinks, Mr. C. G. T. McCaw, and probably Sir S. G. Burrard and Sir G. Lenox-Conyngham.

THE British Motor Cycle and Cycle-car Research Association has been approved by the Department of Scientific and Industrial Research as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. The association may be approached through Major H. R. Watling, "The Towers," Warwick Road, Coventry.

THE Civil Service Commission of Canada announces the promotion of Mr. Arthur Gibson to the position of Dominion Entomologist and head of the Entomological Branch of the Dominion Department of Agriculture. Mr. Gibson has been Acting Dominion Entomologist since the death of Dr. C. Gordon Hewitt in February last.

THE Institute of Industrial Administration, 110 Victoria Street, London, S.W.1, has among its objects "the general advancement of knowledge relative to the principles of industrial administration and their applications." The inaugural meeting was held on October 23, when an address on the industrial question was given by Viscount Haldane. Other meetings to be held are as follows:—November 9, The Influence of Exposed Records on Output, F. M. Lawson; November 23, Staff Selection and Promotion, E. W. Cousins; December 7, Road Transport as an Aid to Industrial Management, R. Twelvetrees; December 21, Standardisation of Rate-fixing Methods, J. E. Powell; January 11, 1921, The Measure of Output in Agriculture, W. J. Malden; and January 25, News and its Influence on Output, H. S. Rylands.

MR. F. S. SPIERS, secretary of the Faraday Society, was recently appointed by the King an Officer of the British Empire (O.B.E.), and reference was made to this honour at the opening of the joint meeting on the physics and chemistry of colloids described elsewhere in this issue. Mr. Spiers has been responsible for the organisation of the many valuable joint conferences arranged by the Faraday Society during Sir Robert Hadfield's presidency, and everyone who has attended any of them will be glad to know that his work has met with official recognition. He was secretary of the two British Scientific Products Exhibitions organised in 1918 and 1919 by the British Science Guild, and is secretary of the Institute of Physics, which there is every reason to believe will eventually occupy a very strong position among scientific bodies.

IN recent notes in the *Astr. Nachr.* (No. 5047) and the Paris *Comptes rendus* (vol. clxxi., p. 520) Prof. Carl Störmer describes most interesting results from photographic observations made at seven stations in Norway on the height of a very brilliant aurora seen on the night of March 22–23 last. More than six hundred photographs were taken. Only some of the plates have been fully studied, but these give for the summits of some of the auroral rays heights *of the order of* 500 *km.* Prof. Störmer describes a unique corona, seen on March 23 about 3h. 45m. a.m. G.M.T., of "long blue rays of indescribable beauty." Of this he himself, at his station at Bygdo, near Christiania, obtained several photographs, but unfortunately by that time all his other stations had run out of plates. He is anxious to know whether anyone else obtained a photograph of the blue rays, as he thinks their height was probably quite exceptional.

THE second reading of the British Empire Exhibition (Guarantee) Bill was carried in the House of Commons on November 1. The exhibition is to be held in London in 1923, and to be representative of the industries and resources of the British Empire. It will be privately organised, but has received official recognition and support. The King has given it his patronage, and the Prince of Wales is to be president of the General Committee. Under the Bill the Government proposes to guarantee the sum of 100,000*l.*, subject to private guarantees amounting to 500,000*l.* being forthcoming. As a condition of the guarantee, the Board of Trade is to approve the manager of the exhibition, the executive committee, and the general conditions under which the exhibition will be run, so that the Government may be in a position to secure that the exhibition is conducted with proper regard to economy and on lines which will ensure a success worthy of the object in view.

THE usual winter courses of the Ecole d'Anthropologie began at Paris on November 3. Prof. Manouvrier's subject is the anthropological problems of heredity; Prof. Hervé's the regional ethnology of France and the conclusion of a study of crossings; Prof. Mahoudeau's the naturalists and philosophers of the eighteenth century, and the struggle against creationism; Prof. de Mortillet's labour, industry, and commerce among primitive peoples; Prof. Capitan's the most recent observations upon the megaliths of Brittany, upon Alsatian and Belgian prehistorics, and, generally, upon the architecture and art of prehistoric times; Prof. Schrader continues his teaching on the normal and abnormal relations of modern civilisation with natural laws; Prof. Papillault lectures on the psycho-sociology of art; Prof. Zaborowski on the ancient and modern peoples of Europe and America; Prof. Anthony on morphological determinism in biology; and Prof. Vinson on the languages of Europe. We miss the usual announcement of conferences.

PROF. ROGET in his third Chadwick lecture, delivered on Friday, October 29, dealt with the future activities in the civil community of the public health department of the League of Red Cross Societies. The work to be undertaken has been divided up among seven sections. The first is concerned with social diseases. The lecturer pointed out the difficulty of including these affections in Red Cross work; nevertheless, he is of opinion that science is bound to do its utmost to stamp out the "social evil." At the same time every moral and religious influence must also be brought to bear on the subject. The second section will deal with the prevention of tuberculosis. Prof. Roget stated that both preventive methods and the segregation of tuberculous persons must be employed in this work. The third section will be devoted to the prevention of malaria, chiefly by carrying out scientific changes which have been proved to be effective in the administration of areas in which the disease is rife. Child welfare and nursing will be the work of the fourth section. With the collaboration of the visiting nurse with the mother work can be done which is peculiarly suited to Red Cross organisations. Another section is concerned with preventive medicine; preventive service could be efficient only when a large number of Red Cross laboratories had been placed at the disposal of the medical practitioner. The seventh section would have the greatest task of all, that of education. Museums, lectureships, health libraries, and literature were all necessary, particularly in those countries in which hygiene, sanitation, and clean housing are neglected.

IN an important paper by Mr. A. L. Kroeber on "California Culture Provinces" (University of California Publications in Ethnology, vol. xvii., No. 27) the author dismisses the theory held by American ethnologists that California represents a well-defined culture area. This region falls more properly into three areas: northern, central, and southern. Of these the northern is part of the culture of the North Pacific coast, with its centre in British Columbia. In the south the foundation of everything is Mexican, but the culture has taken its peculiar shape and colour on the spot. What the author says of the south-west may be generally applied to the other regions: "The truth is that the south-west is too insuperably complex to be condensed into a formula or surrounded with a line on the map."

OBSERVERS of social life in India have long been aware that certain varieties of the sári or sheet are distinctive marks of caste. In the October issue of *Man* Mr. R. S. Nicholson describes some remarkable methods of ornamentation of the sári which prevail in the Cuddapa district of the Madras Presidency. New cloths, though they may have been previously procured, are assumed in the eighth month of the Telugu year, corresponding with October–November. Each type of cloth has a special border, indicating the god in whose honour the cloth is worn—a special colour for the Nága or snake god, the Mother goddesses, and so on. These special marks on women's cloths seem to be peculiar to Southern India, and, so far as has hitherto been observed, do not prevail in the north.

MUCH interest has lately been excited by the attempted breeding of a pair of bee-eaters in Scotland. These birds took up their quarters on a sandbank of the River Esk at Musselburgh, and it seemed at one time probable that they would succeed in rearing young. A full account of this attempt and its lamentable ending is given by Dr. Eagle Clarke in the September–October issue of the *Scottish Naturalist*.

THE *Philippine Journal of Science* (vol. xvi., No. 4) is devoted to an interesting and valuable survey of the avifauna and flora of the Philippines. The author, Mr. R. C. McGregor, gives a condensed but vividly written account of the various types of forest of this region in relation, on one hand, to their economic value, and, on the other, to the problems they present to the ecologist. He then proceeds to give a lively review of the birds of this area and their distribution in regard to the different types of forest, supplementing his observations by comparisons with other types of tropical forests in Africa and America. To naturalists at large this essay will prove supremely interesting and helpful. Furthermore, it is illustrated by a number of beautiful plates.

MEMOIRS of the Agricultural Department of India, Entomological Series, vol. v., No. 5 (May, 1920), deals with two destructive species of rice-leaf hoppers. This well-illustrated brochure by C. S. Misra emphasises the great damage done by these insects. In the Chhattisgarh Division of the Central Provinces in 1914 they were reported to have damaged 3,000,000 acres, causing a loss approximately of 14,000,000 rupees. From observations conducted on the habits of these insects it was ascertained that they have a strong predilection for light. In order to apply the use of light traps satisfactorily it was necessary that the cultivators should co-operate in the work, but the Chhattisgarhi ryot is both superstitious and lethargic. No amount of persuasion could induce him to go to his fields at night and light the lamps, owing to his innate dread of evil spirits. Among other methods the necessity for clean cultivation and the elimination of all grassy areas in the immediate vicinity of the paddy fields is emphasised. The use of large field-bags, 6 ft. long, 4 ft. broad, and 4 ft. deep, attached to a light bamboo frame is also advised. Each bag can be carried by two men at a walking pace and drawn through the fields when the plants are small. The inside of the bags should be smeared with kerosene in order to prevent the leaf-hoppers from escaping when once they are caught. The possibility of selecting immune varieties of paddy is a subject worth consideration, together with the relation of the ripening period to the incidence of the pests.

SEALING operations at the Pribilof Islands closed for the season on August 10, and the United States Bureau of Fisheries reports that telegraphic information has been received stating that a total of 25,978 pelts had been taken during this calendar year (*Science*, October 8). Of this number 21,936 were taken on St. Paul Island and the remainder on St. George Island; 721 of the pelts were from seals seven years of age or older. A by-products plant was in operation on St. Paul Island which produced some 1800 gallons of oil and 29,000 lb. of meat or fertiliser. These figures could have been exceeded if the Bureau had been able to obtain more labourers from the Aleutian Islands. Comments are made on the rumour that the United States Government intends to remove restrictions on pelagic sealing in the North Pacific Ocean and Bering Sea. North of the thirtieth parallel of north latitude, and in the seas of Bering, Kamchatka, Okhotsk, and Japan, pelagic seal-fishing is prohibited by an agreement entered into in 1911 by the United States, Great Britain, Russia, and Japan, which is in perpetuity unless one or more of the signatories dissent from it. This agreement has never been rescinded, and in face of the benefits which have been shown to accrue from the proper management of fur-seal herds—in the fiscal year 1920 the United States revenue from the sale of skins was 1,457,790 dollars, and Great Britain and Japan take shares of 15 per cent. each of the annual catch—there is no likelihood of the re-introduction of pelagic seal-fishing. The Alaskan herd is protected by the patrolling vessels of the United States and Canada working in co-operation.

THE *Lancet* of October 23 contains an interesting account of an outbreak of Senecio disease, or cirrhosis of the liver due to Senecio poisoning, which occurred in the George district of Cape Province, Union of South Africa, in 1918. Dr. F. C. Willmot and Mr. G. W. Robertson, the authors of the article, state that the disease has been traced to the presence of the toxic seeds of *Senecio ilicifolius* and *Senecio Burchelli* in wheat harvested from fields in which these weeds were prevalent. They mention that precisely similar diseases (Molteno disease in South Africa, Winton's disease in New Zealand, and Pictou disease in Nova Scotia) have long been known in farm animals, especially horses, but they appear to be unaware that so long ago as 1911 Dr. H. E. Watt, working in the Imperial Institute laboratories, isolated from *Senecio latifolius*, the plant chiefly suspected of causing the disease in horses in South Africa, two toxic alkaloids, senecifoline and senecifolidine. These alkaloids were afterwards examined pharmacologically by Prof. Cushny, and found to produce hepatic cirrhosis in the animals used, the symptoms and post-mortem findings being identical in all respects with those recorded by the veterinary surgeons who have dealt with cases of Molteno, Winton's, or Pictou disease in South Africa, New Zealand, and Canada respectively. The outbreak now recorded by Dr. Willmot and Mr. Robertson is, however, probably the first instance of Senecio poisoning in human beings, and it raises the interesting question of the possible occurrence of cases in Europe, since *Senecio jacobaea*, the source of the disease in sheep in Nova Scotia, is a common weed in the United Kingdom and throughout Europe. In this country, however, the cleaning of wheat prior to its conversion into flour is probably so efficiently done that the risk is negligible.

WANDERING storms form the subject of an article by Prof. A. McAdie, of Harvard University, in the *Geographical Review* for July last. The communication is for the most part based on Sir Napier Shaw's "Manual of Meteorology," part iv., published during the war, which discusses the relation of the wind to barometric pressure and the travel of cyclones. Prof. McAdie instances three unusual storm tracks dealt with by Sir Napier Shaw, and alludes to the need in forecasting of knowledge of recurving storms, with especial reference to the aviator and his long-distance flights. A remarkable instance is given by the author of the erratic travel of a disturbance from May 8 to June 6, 1910. This is tracked from the Strait of Juan de Fuca to the Grand Banks, when it is said to have recurved again and again, and to have come back to the Continent on May 26. It then merged with a storm that was moving north from Texas, and after meandering about to the east and north-east of Nova Scotia for ten days, until June 6, the disturbance dissipated.

THE October issue of the *Abstracts and Papers* published by the Institution of Civil Engineers contains 300 abstracts occupying more than 200 pages, and an index of 12 pages. The necessity for such a publication if the results of foreign investigations are to be made available in the engineering industries of this country will be apparent to every reader. Taking the abstracts which deal with the uses and properties of concrete for structural purposes, we find that a five years' experience in Germany of the use of furnace-slag as a substitute for gravel and sand in concrete has shown that slag-concrete is stronger than concrete made of Rhine sand. The conditions under which Portland cement can be stored for a couple of years without the strength of the concrete made from it suffering have been investigated in America. In Germany a saving of 17 per cent. has been effected by the substitution of concrete for brick in workmen's dwellings. In South Africa the manufacture of large pipes of concrete by the centrifugal process has proved successful. In Belgium the best way of driving concrete piles without injury to them has been investigated; while the American Railway Engineers' Association has found concrete road-beds uniformly successful.

IN the *Journal de Physique* for August last MM. H. Abraham, E. Bloch, and L. Bloch describe their direct-reading thermionic voltmeter which is manufactured by Carpentier. The invention of this instrument is a notable step in the development of the science of electrical measurement. Hitherto it has been impossible to get a direct-reading voltmeter which would read one volt of alternating pressure accurately. This instrument gives a direct reading for the ten-millionth part of an alternating volt. It consists of two thermionic amplifiers, followed by two thermionic valves in parallel, the "plate" current of which is measured by an ordinary direct-current milliammeter. With the help of this instrument the measurement of very minute alternating currents and pressures is as simple as everyday measurements with ordinary voltmeters and ammeters. By its use absolute measurements of inductances and capacities are made in a few minutes with a maximum inaccuracy of about 1 in 1000. By the use of suitable electrical "filters" very approximately sine-shaped waves are obtained by blocking out the disturbing harmonics. The authors have shown recently in the same journal how the frequency of the alternating currents can be determined with high accuracy. Its sensitiveness is shown by the fact that it can measure, by means of a direct reading of the pointer, the capacity of a sphere one millimetre in radius. The instrument has very many useful applications.

SOME comments on the statistics just issued by *Lloyd's Register* for the quarter ending on September 30 appear in *Engineering* for October 22. Before the war the merchant tonnage under construction in this country usually exceeded the total building in all other countries in the world; at present the tonnage building abroad exceeds our tonnage under construction by about 103,000 tons. At the end of September the vessels building in this country numbered 961 with a total gross tonnage of 3,731,098, an increase during the year of more than 32 per cent.; in comparison with the figure for September, 1913, the increase is more than 90 per cent. The individual tonnage in no case exceeds 25,000. With regard to the tonnage building abroad, the most noticeable feature is the decline in the tonnage building in the United States, where there are now only 312 vessels with an aggregate gross tonnage of 1,772,193 in hand, as compared with 767 vessels and a gross tonnage of 3,470,748 for the corresponding quarter of last year. Of the vessels now under construction, 114 with a total gross tonnage of 796,060 are intended for carrying oil in bulk. The United States is building 79 of these ships, and there are 32 building in the United Kingdom. Only five small steamers are being constructed of reinforced concrete in the United Kingdom, their total tonnage amounting to 2354; eleven vessels of this type are being built abroad, having a total tonnage of 24,069.

THE miscellaneous catalogue (No. 2, 1920) of second-hand books just issued by Mr. W. H. Robinson, 4 Nelson Street, Newcastle-upon-Tyne, contains nearly a thousand items, about two hundred of which deal with scientific subjects. The prices asked for the works appear very reasonable. The catalogue can be obtained upon application.

WE have received from the firm of Scientific Appliances, Southampton Row, W.C.1, a copy of its illustrated catalogue, which shows the apparatus available in two sections of the establishment. Section E contains electrical and magnetic apparatus, and fittings such as telephone sets, lighting sets, Wimshurst machines, accumulators, etc. Section O comprises optical appliances and drawing materials.

Our Astronomical Column.

COMETS.—Dr. Kudara, who rediscovered Tempel's second comet last May, gives the following revised elements for it in *Popular Astronomy* for October. He also gives the corrected R.A. for the observation on May 25 last as 22h. 55m. 43·7s.:

$$T = 1920 \text{ June } 16{\cdot}196 \text{ G.M.T.}$$
$$\left.\begin{aligned}\omega &= 186^\circ\ 39'\ \ 0''\\ \Omega &= 120^\circ\ 46'\ \ 5''\\ i &= 12^\circ\ 45'\ 14''\\ \phi &= 33^\circ\ 54'\ 21''\end{aligned}\right\}1920{\cdot}0$$
$$\mu = 687{\cdot}51''$$
$$\log a = 0{\cdot}47515$$

The period is the shortest of any known comet with the exception of that of Encke.

Popular Astronomy also contains the following elements of Borrelly's comet (1905 II.) deduced by Mr. F. E. Seagrave from observations on 1918 October 9 and December 6 and 1919 February 4:

$T = 1918$ Nov. 16·8632 G.M.T.	$\phi = 37^\circ\ 57'\ 11''$
$\omega = 352^\circ\ 23'\ 32''$	$\mu = 514{\cdot}023''$
$\Omega = 76^\circ\ 57'\ \ 2''$	$\log a = 0{\cdot}559350$
$i = 30^\circ\ 29'\ 14''$	

MOUNT WILSON OBSERVATIONS OF CAPELLA.—Some account of the remarkable observations of Capella as a double star at Mount Wilson, using interferometer methods on the 100-in. equatorial, was given in NATURE last April. The *Astrophysical Journal* for June contains further details; the theory of the interferometer is described by Mr. A. A. Michelson, while Mr. J. A. Anderson discusses the observations of Capella, and finds the orbit from observations on six days ranging from 1919 December 30 to 1920 April 23, combined with the spectroscopic data. The following are the adopted elements: Period = 104·006 days; periastron = Julian day 2422387·9; $a = 0{\cdot}05249'' = 130{,}924{,}000$ km.; $e = 0{\cdot}016$; $i = 140^\circ\ 30'$; $\omega = 117{\cdot}3^\circ$; parallax = 0·0600″; masses of components in terms of sun, 4·62 and 3·65. These elements satisfy the observations with no error exceeding 0·00004″ in distance and 0·9° in position-angle, but the author points out that a longer series would probably show much larger residuals, since the interferometer multiplies the theoretical resolving power by $2\frac{1}{2}$ only.

From the close resemblance of the spectrum of one of the components with that of the sun it is probable that the surface brilliancy is much the same as the sun's, in which case the diameter of each star would be of the order of ten times that of the sun, or one-tenth of the distance between them. It is noted that the visual magnitudes of the two components must be very nearly the same, since the interference fringes completely vanished on superposition.

VARIATION IN THE LIGHT OF JUPITER.—A novel use of the photo-electric cell was made by Herr P. Guthnick at the Berlin-Babelsberg Observatory in an investigation as to whether the light of Jupiter showed any variation in the course of the planet's rotation owing to different markings being presented to us. In fact, last December and January there was a distinct variation having an amplitude of 0·14 magnitude. However, this rapidly diminished, and by February was only 0·04 magnitude. The author remarks that this rapid change gives support to the temporary variability in the light of Neptune in a period of eight hours observed by Prof. Hall and discussed in Monthly Notices, vols. xliv. and lxxv. Unfortunately, Neptune is too faint for observation with the photo-electric cell, otherwise a determination of its rotation-period might result.

Educational Science.*

By SIR ROBERT BLAIR, LL.D.

THE value to education of science and the scientific method has hitherto been for the most part indirect and incidental. It has consisted very largely in deductions from another branch of study, namely, psychology, and has resulted for the most part from the invasion into education of those who were not themselves educationists. A moment has now been reached when education itself should be made the subject of a distinct department of science, when teachers themselves should become men of science.

There is in this respect a close analogy between education and medicine. Training the mind implies a knowledge of the mind, just as healing the body implies a knowledge of the body. Thus, logically, education is based upon psychology, as medicine is based on anatomy and physiology. And there the text-books of educational method are usually content to leave it. But medicine is much more than applied physiology. It constitutes an independent system of facts, gathered and analysed, not by physiologists in the laboratory, but by physicians working in the hospital or by the bedside. In the same way, then, education as a science should be something more than mere applied psychology. It must be built up not out of the speculations of theorists, or from the deductions of psychologists, but by direct, definite, *ad hoc* inquiries concentrated upon the problems of the class-room by teachers themselves. When by their own researches teachers have demonstrated that their art is, in fact, a science, then, and not until then, will the public allow them the moral, social, and economic status which it already accords to other professions. The engineer and the doctor are duly recognised as scientific experts. The educationist should see to it that his science also becomes recognised, no longer as a general topic upon which any cultured layman may dogmatise, but as a technical branch of science, in which the educationist alone, in virtue of his special knowledge, his special training, his special experience, is the acknowledged expert.

Educational science has hitherto followed two main lines of investigation: first, the evaluation and improvement of teachers' methods, and, secondly, the diagnosis and treatment of children's individual capacities.

I. THE PSYCHOLOGY OF THE INDIVIDUAL CHILD.

It is upon the latter problem, or group of problems, that experimental work has in the past been chiefly directed, and in the immediate future is likely to be concentrated with the most fruitful results. The recent advances in "individual psychology"—the youngest branch of that infant science—have greatly emphasised the need, and assisted the development, of individual teaching. The keynote of successful instruction is to adapt that instruction to the individual child. But before instruction can be so adapted the needs and the capacities of the individual child must first be discovered.

A. *Diagnosis*.

Such discovery (as in all sciences) may proceed by two methods: by observation and by experiment.

(1) The former method is, in education, the older. At one time, in the hands of Stanley Hall and his followers—the pioneers of the child-study movement—observation yielded fruitful results. And it is perhaps to be regretted that of late simple observation and description have been neglected for the more ambitious method of experimental tests. There is much that a vigilant teacher can do without using any special apparatus and without conducting any special experiment. Conscientious records of the behaviour and responses of individual children, accurately described without any admixture of inference or hypothesis, would lay broad foundations upon which subsequent investigators could build. The study of children's temperament and character, for example—factors which have not yet been accorded their due weight in education—must for the present proceed upon these simpler lines.

(2) With experimental tests the progress made during the last decade has been enormous. The intelligence scale devised by Binet for the diagnosis of mental deficiency, the mental tests employed by the American Army, the vocational tests now coming into use for the selection of employees—these have done much to familiarise, not school teachers and school doctors only, but also the general public, with the aims and possibilities of psychological measurement. More recently an endeavour has been made to assess directly the results of school instruction, and to record in quantitative terms the course of progress from year to year, by means of standardised tests for educational attainments. In this country research committees of the British Association and of the Child-Study Society have already commenced the standardisation of normal performances in such subjects as reading and arithmetic. In America attempts have been made to standardise even more elusive subjects, such as drawing, handwork, English composition, and the subjects of the curriculum of the secondary school.

B. *Treatment*.

This work of diagnosis has done much to foster individual and differential teaching—the adaptation of education to individual children, or at least to special groups and types. It has not only assisted the machinery of segregation—of selecting the mentally deficient child at one end of the scale and the scholarship child at the other—but it has also provided a method for assessing the results of different teaching methods as applied to these segregated groups. Progress has been most pronounced in the case of the sub-normal. The mentally defective are now taught in special schools, and receive an instruction of a specially adapted type. Some advance has more recently been made in differentiating the various grades and kinds of so-called deficiency, and in discriminating between the deficient and the merely backward and dull. With regard to the morally defective and delinquent little scientific work has been attempted in this country, with the sole exception of the new experiment initiated by the Birmingham justices. In the United States some twenty centres or clinics have been established for the psychological examination of exceptional children; and in England school medical officers and others have urged the need for "intermediate" classes or schools not only to accommodate backward and borderline cases and cases of limited or special defect (*e.g.* "number-defect" and so-called "word-blindness"), but also to act as clearing-houses.

In Germany and elsewhere special interest has been aroused in super-normal children. The few investigations already made show clearly that additional attention, expenditure, study, and provision will yield

* From the opening address of the President of Section L (Educational Science) delivered at the Cardiff Meeting of the British Association on August 24.

for the community a far richer return in the case of the super-normal than in the sub-normal.

At Harvard and elsewhere psychologists have for some time been elaborating psychological tests to select those who are best fitted for different types of vocation. The investigation is still only in its initial stages, but it is clear that if vocational guidance were based, in part at least, upon observations and records made at school instead of being based upon the limited interests and knowledge of the child and his parents, then not only employers, but also employees, their work, and the community as a whole, would profit. A large proportion of the vast wastage involved in the current system of indiscriminate engagement on probation would be saved.

The influence of sex, social status, and race upon individual differences in educational abilities has been studied upon a small scale. The differences are marked; and differences in sex and social status, when better understood, might well be taken into account both in diagnosing mental deficiency and in awarding scholarships. As a rule, however, those due to sex and race are smaller than is popularly supposed. How far these differences, and those associated with social status, are inborn and ineradicable, and how far they are due to differences in training and in tradition can scarcely be determined without a vast array of data.

II. TEACHING METHODS.

The subjects taught and the methods of teaching have considerably changed during recent years. In the more progressive types of schools several broad tendencies may be discerned. All owe their acceptance in part to the results of scientific investigators.

(1) Far less emphasis is now laid upon the *disciplinary value of subjects*, and upon subjects the value of which is almost solely disciplinary. Following in the steps of a series of American investigators, Winch and Sleight in this country have shown very clearly that practice in one kind of activity produces improvements in other kinds of activities only under very limited and special conditions. The whole conception of transfer of training is thus changed, or (some maintain) destroyed; and the earlier notion of education as the strengthening, through exercise, of certain general faculties has consequently been revolutionised. There is a tendency to select subjects and methods of teaching rather for their material than for their general value.

(2) Far less emphasis is now laid upon an advance according to strict *logical sequence* in teaching a given subject of the curriculum to children of successive ages. The steps and methods are being adapted rather to the natural capacities and interests of the child of each age. This genetic point of view has received great help and encouragement from experimental psychology. Binet's own scale of intelligence was intended largely as a study in the mental development of the normal child. The developmental phases of particular characteristics (*e.g.* children's ideals) and special characteristics of particular developmental phases (*e.g.* adolescence) have been elaborately studied by Stanley Hall and his followers. Psychology, indeed, has done much to emphasise the importance of the post-pubertal period—the school-leaving age, and the years that follow. Such studies have an obvious bearing upon the curriculum and methods for our new continuation schools. But it is, perhaps, in the revolutionary changes in the teaching methods of the infants' schools—changes that are already profoundly influencing the methods of the senior department—that the influence of scientific study has been most strongly at work.

(3) Increasing emphasis is now being laid upon *mental and motor activities*. Early educational practice, like early psychology, was excessively intellectualistic. Recent child-study, however, has emphasised the importance of the motor and of the emotional aspects the child's mental life. As a consequence, the theory and practice of education have assumed more of the pragmatic character which has characterised contemporary philosophy.

The progressive introduction of manual and practical subjects, both in and for themselves, and as aspects of other subjects, forms the most notable instance of this tendency. The educational process is assumed to start not from the child's sensations (as nineteenth-century theory was so apt to maintain), but rather from his motor reactions to certain perceptual objects—objects of vital importance to him and to his species under primitive conditions, and therefore appealing to certain instinctive impulses. Further, the child's activities in the school should be not, indeed, identical, but continuous, with the activities of his subsequent profession or trade. Upon these grounds handicraft should now find a place in every school curriculum. It will be inserted both for its own sake and for the sake of its connections with other subjects, whether they be subjects of school life, of after life, or of human life generally.

(4) As a result of recent psychological work, more attention is now being paid to the *emotional, moral, and aesthetic* activities. This is a second instance of the same reaction from excessive intellectualism. Education in this country has ever claimed to form character as well as to impart knowledge. Formerly this aim characterised the public schools rather than the public elementary schools. Recently, however, much has been done to infuse into the latter something of the spirit of the public schools. The principle of self-government, for example, has been applied with success not only in certain elementary schools, but also in several colonies for juvenile delinquents. And in the latter case its success has been attributed by the initiators directly to the fact that it is corollary of sound child-psychology.

Bearing closely upon the subject of moral and emotional training is the work of the psycho-analysts. Freud has shown that many forms of mental inefficiency in later life—both major (such as hysteria, neurosis, certain kinds of "shell-shock," etc.) and minor (such as lapses of memory, of action, slips of tongue and pen)—are traceable to the repression of emotional experiences in earlier life. The principles themselves may, perhaps, still be regarded as, in part, a matter of controversy. But the discoveries upon which they are based vividly illustrate the enormous importance of the natural instincts, interests, and activities inherited by the child as part of his biological equipment; and, together with the work done by English psychologists such as Shand and McDougall upon the emotional basis of character, have already had a considerable influence upon educational theory in this country.

(5) Increasing emphasis is now being laid upon *freedom* for individual effort and initiative. Here, again, the corollaries drawn from the psycho-analytic doctrines as to the dangers of repression are most suggestive. Already a better understanding of child-nature has led to the substitution of "internal" for "external" discipline; and the predetermined routine demanded of entire classes is giving way to the growing recognition of the educational value of spontaneous efforts initiated by the individual, alone or in social co-operation with his fellows.

In appealing for greater freedom still, the new psychology is in line with the more advanced educational experiments, such as the work done by Madame Montessori and the founders of the Little Commonwealth.

(6) The *hygiene and technique of mental work* is itself being based upon scientific investigation. Of the numerous problems in the conditions and character of mental work generally, two deserve special mention—fatigue and the economy and technique of learning.

But of all the results of educational psychology, perhaps the most valuable is the slow but progressive inculcation of the whole teaching profession with a scientific spirit in their work, and a scientific attitude towards their pupils and their problems. Matter taught and teaching methods are no longer exclusively determined by mere tradition or mere opinion. They are being based more and more upon impartial observation, careful records, and statistical analysis—often assisted by laboratory technique—of the actual behaviour of individual children.

Popular Relativity and the Velocity of Light.[1]

By Sir Oliver Lodge, F.R.S.

In using the phrase "popular relativity" I indicate that what I am criticising is not Einstein's equations—which seem to have justified themselves by results—but some of the modes of interpreting them in ordinary language. Especially do I attack that proposition which asserts that to every observer the velocity of light will not only be constant in reality, but will also superficially appear constant even when he ignores his own motion through the light-conveying medium—a proposition or postulate or axiom which has been shown to lead to curious and, as I think, illegitimate complications, threatening to land physicists in regions to which they have no right of entry, and tempting them to interfere with metaphysical abstractions beyond their proper ken.

Not that a physicist's proper ken is limited to what he immediately observes; he is entitled, and indeed required, to interpret appearances rationally by taking into account every relevant adventitious circumstance, including complications due to his own unobserved, and perhaps unobservable, travel through space.

In a relativity discussion at the Physical Society recently a member is reported to have asked the pertinent question: "Does an observer merely observe, or does he think as well?" If he thinks, I urge that he can allow for changes in his measuring instruments and any other consequences of possible motion, and can refrain from making deductions about space and time on the strength of experiments on matter.

He will know that his senses are material senses, and that all his experiments are made ultimately by their aid. He will know that he can only experiment even on the æther of space indirectly by means of matter, for he has no other means of getting a grip on it. Possibly he may be unable to grip it even thus, but matter gives him his only chance; he certainly cannot experiment on abstractions like space and time.

On the basis of material experiments he may be able to make deductions or draw inferences about the æther, because that certainly has some inter-relations with matter; but it is probably illegitimate, on the basis of material experiments, to make deductions about space and time at all; they are not likely to be affected by anything that matter can do, and it is only matter with which we can directly deal.

The relation between space and time that represents the velocity of light gives us directly one property of the æther, viz. the product of its electric and magnetic constants, both of which separately are at present unknown. Every student who accepts the æther of space as a reality is probably ready to admit that the velocity of light through free æther is an absolute constant, not dependent on anything that either the observer or the source is doing, has done, or may do.

But this admission has been erected into a fetish by the theory of relativity, at least when expressed in ordinary words, and is interpreted as requiring that to every observer, whatever he may be doing, the velocity of light in every direction will *appear* the same.

That is not only a different, it is a contradictory, proposition. Given the constancy of the real velocity of light—if an observer travel to meet it, it must appear to arrive more quickly than if he travel away from it, provided he has any means of making the observation at all. He may be unable to make the observation, but suppose he can make it, say by the aid of Jupiter's satellites, and detected a discrepancy, he need not infer any real change in the velocity of light; because, if he thinks, he can attribute any observed difference to his own motion, and thereby emerge with clear and simple views. If he sets out with the gratuitous notion that he can never become aware of his own motion, or that his own motion has no meaning, he will indeed encounter a puzzling universe, and will presently long for a Copernicus to unravel the subjective complexities of observation.

But it may well be extremely difficult for an observer to measure the velocity of light through the æther except with the aid of some return signal which the æther likewise has to transmit in the opposite direction; and in that case he may find that the to-and-fro pair of journeys take exactly the same time in every direction.

This, as everyone knows, has been done for a to-and-fro journey of a beam of light. And the timing is exact, not only to the first order of small quantities, as might readily be expected, but to the second order also—an exactitude which, if rigid unchangeable materials could be used, would not be expected, and ought not to occur. But if the dimensions of the material object used as the foundation-stone of his apparatus are subject to change by reason of motion, and if the changes are in accordance with the electrical theory of matter, as suggested by FitzGerald and elaborated by Lorentz, then everything becomes clear again until we come to astronomical and gravitational applications, and the precisely negative result of Michelson and Morley is precisely explained.

A mathematical doctrine of relativity may be based upon this experimental result, and may be convenient for reasoning purposes, but no such doctrine is required by the facts. The facts are patient of the doctrine; they do not compel it, nor do they justify it. Any comprehensive mathematical expression is liable to permit other modes of interpretation, as well as the simplest and truest or the one most directly applicable to the problem in hand. It is devised to cover one set of facts, but in its generality it is apt

[1] The substance of this controversial note was communicated to Section A of the British Association at the Cardiff meeting on August 27.

to cover more. Why, then, proceed to build up on an equation an elaborate metaphysical structure? And, especially, why imagine that the success of the Einstein equation proves the observed velocity of light to be the same whatever the motion of the observer? If the observer thinks, and if he is aware of the FitzGerald-Lorentz contraction, he will know that such a proposition is not true; he will know that the velocity of light is not equal in all directions in a relatively drifting medium, that the wave-front is not concentric to the observer, and that the Michelson experiment gives no proof of anything of the kind.

The uniformity of the æther makes the obtaining of positive results difficult; there seem to be always compensations. Some day we may be able to evade this experimental difficulty, but meanwhile, if we choose to make the supposition that motion of the observer can never have any directly observable effect, or that one set of axes of reference is necessarily equivalent to every other and indistinguishable by any kind of superficial observation, then we seem to be in accord with present experience. From that supposition definite consequences can, with adequate skill, be deduced, and the deductions have been subjected to successful verification.

But if on the strength of that remarkable achievement some enthusiasts proceed to formulate propositions which by ignoring the motion of the observer and all its consequences complicate the rest of the universe unduly, then, however much we may admire their skill and ability, I ask whether they ought not to be regarded as Bolsheviks and pulled up.

Emil Fischer's Contributions to Organic Chemistry.[1]

By DR. M. O. FORSTER, F.R.S.

EMIL FISCHER was born on October 9, 1852, at Euskirchen, and his death on July 14, 1919, occurred at a time when every element of constructive and harmonising influence was most sorely needed. Since 1892, when he succeeded von Hofmann, he had fulfilled the duties of professor and director of the chemical institute in the University of Berlin with increasing distinction. Physically commanding, his authority rested on the solid foundation of natural dignity. The brisk, upright carriage marked the man of action; the glowing eyes revealed his attitude of constant, keen inquiry; it was impossible to escape his contagious enthusiasm.

Fischer addressed himself to organic chemical research at the opening of its brightest epoch. Having described the preparation of phenylhydrazine in 1875, he devoted many succeeding years to developing the transformations of that remarkable substance. During this period he also collaborated with his cousin, Otto Fischer, in elucidating the constitution of rosaniline bases, their first joint paper appearing in 1876. It is noteworthy that, in spite of his early interest in the chemistry of these and other colouring matters, and notwithstanding his association with von Baeyer, beginning in Strasbourg and continuing until he left Munich to occupy the chair of chemistry at Erlangen in 1882, he nevertheless resisted the temptation to succeed Caro as director of research in the Badische factory, although at this time (1883) the colour industry was in the early flush of its active growth.

When reviewed as a chapter which is closed, Fischer's work must be regarded as having established upon a firm basis the fundamental science of biochemistry. The assimilation of carbon dioxide and water by plants, the variety and complexity of saccharide molecules proceeding therefrom, the degradation of the proteins, the probable course of their synthesis from amino-acids, and the power of assemblage or of disruption exerted by enzymes on all these building materials of the animal and vegetable kingdoms are subjects which Fischer not merely illuminated, but was the first to place in coherent arrangement and intelligible sequence. Recognition of the fact that all this was accomplished, not by revolutionary processes or theories, but by skilful development of the thoughts and operations expanded by Liebig, von Hofmann, Pasteur, and von Baeyer, is perhaps the highest tribute which can be paid to his genius.

Fischer's association with the branch of chemistry which first brought him fame began in 1884, when he discovered phenylglucosazone, produced from glucose, fructose, and mannose by the action of phenylhydrazine. At that time only two aldohexoses (glucose and galactose) and two ketohexoses (fructose and sorbose) were known and recognised as straight-chain pentahydroxy-derivatives. According to the requirements of van't Hoff's theory, a pentahydroxy-aldehyde of this class, in which five carbon atoms are each associated with one hydroxyl group, should appear in sixteen stereoisomeric forms, eight of these being enantiomorphs of the remainder. The bare statement that Fischer and his collaborators elucidated the configuration of twelve such isomerides, most of which they synthesised for that purpose, although perhaps an accurate summary of his opening achievement, conveys but a nebulous impression of the character and amount of the labour involved. Moreover, his discovery of γ-methylglucoside in 1914, and the consequent recognition of cyclic relations distinct from that occurring in α- and β-glucose, have opened the way to a multitude of contingent isomerides, those of *d*-glucose alone numbering ten. Thus Fischer not only elaborated his own sugar chemistry, but also added to this the foundation of a new carbohydrate classification.

The directive influence on Fischer's work in this field was the discovery, in association with Tafel in 1887, of α- and β-acrose. The former sugar he identified with *dl*-fructose, whilst β-acrose is now recognised as *dl*-sorbose. The above-mentioned synthetical operations, and many others connected with pentoses, tetroses, and artificial sugars containing more than six atoms of carbon, were effected by means of the cyanohydrin reaction, Pasteur's method of separating optical antipodes, and the discovery that when a monobasic sugar-acid is heated with quinoline at 140° C. the configuration of the carbon atom adjacent to the carboxyl group becomes epimerised (1890).

One of the most remarkable achievements in a series unsurpassed by any organic chemist was Fischer's synthesis of the principal constituent of Chinese tannin. In 1852 Strecker had shown that gall-nut tannin is a compound of grape-sugar and gallic acid, but latterly the conclusion had become discredited, and tannin was regarded as consisting mainly of digallic acid. This was synthesised in 1908 by Fischer and found to be crystalline, although astringent, and in 1912 he showed that the principal constituent of Chinese tannin does give glucose on hydrolysis. By a series of complex synthetical opera-

[1] Synopsis of the Emil Fischer Memorial Lecture delivered before the Chemical Society on October 28.

tions in association with Bergmann he prepared in 1918 the penta-(*m*-digalloyl)-derivatives of α- and β-glucose, and found them to be indistinguishable from the principle of Chinese tannin excepting for a slight difference in optical activity.

Fischer is entitled to a high place amongst the notable figures in chemical history associated with problems arising from the structure of uric acid and its derivatives. This work, begun in 1881, when he resolved caffeine into methylcarbamide and dimethylalloxan, reached its climax in 1898, when he derived purine from uric acid by means of indirect deoxidation. It has now passed into the text-books, and the classification of all such materials, many of which are important products of animal and vegetable metabolism, is based on his notation of 1897.

In view of their extent and the far-reaching biochemical conclusions based upon them, the labours of Fischer in the region of proteins make the same appeal to the imagination and evoke the same delight in craftsmanship as his activities amongst carbohydrates. Recognising amino-acids as the building materials of albuminoid molecules, he devised an unrivalled practical method for isolating them from the complex mixtures which follow the hydrolytic disruption of the proteins. Accumulating a large number of such units in their optically active forms, he proceeded to reassemble them as anhydrides, and thus elaborated molecules which, although much simpler than natural proteins, nevertheless approach them in physical properties. These were called polypeptides, and one of them, an octadecapeptide described in 1907, attained a molecular weight of 1213. The experimental methods developed in the course of these investigations are too complex for summary description, but they represent an extraordinary technical feat, and establish a connecting link between laboratory syntheses and the peptones arising from incomplete disruption of protein molecules. The investigation is limited only by material considerations, for a calculation made by Fischer in 1916 showed that the octadecapeptide has 816 possible isomerides, whilst a polypeptide involving thirty amino-acid molecules differing widely, but not entirely, amongst themselves may have isomerides reaching $1 \cdot 28 \times 10^{27}$ in number.

Throughout these inquiries Fischer made frequent and skilful use of enzymes, developing a technique which will offer substantial guidance to later investigators of vital changes. In 1894, having assembled a variety of artificial carbohydrates, he studied their behaviour towards different families of yeast, drawing the fundamental conclusion that the fermentative enzyme is an asymmetric agent attacking only those molecules of which the configuration does not differ too widely from that of *d*-glucose. Applying this principle to the natural and artificial *d*-glucosides, he ranged these in two groups, the α-*d*-glucosides being hydrolysed by maltase and indifferent towards emulsin, the β-*d*-glucosides exhibiting converse behaviour. The *l*-glucosides, *d*-galactosides, arabinosides, xylosides, rhamnosides, and glucoheptosides were not affected by either enzyme, and the glucosidic relation of sucrose, maltose, and lactose was determined by similar means. It was the knowledge thus gained which led Fischer to represent enzyme-action by the analogy of a lock-and-key, and to conclude that disaccharides are fermented only as a consequence of preliminary hydrolysis. Turning his attention to secretions of animal origin (1896), he studied the behaviour of carbohydrates and glucosides towards a great variety of tissue extracts and juices, but it was when these were applied by him, in association with Abderhalden (1903), to the proteins and polypeptides that the most fruitful results arose, from which it followed very clearly that the synthetic polypeptides are susceptible to zymolysis only when constructed of those amino-acids which occur in the natural proteins themselves.

Although the subjects to which Fischer mainly devoted his attention were not related directly to problems of manufacture, he quickly made contact with the chemical industry, and many of the processes in use at the Bayer, Höchst, and Böhringer factories were based upon principles developed in his laboratory; the improvement which he effected in the production of diethylbarbituric acid led to this compound becoming one of the most valuable hypnotics in pharmacy under the name "veronal." Whilst shunning publicity in its grosser forms, he played an active part in the German chemical world, and the reliance placed on his judgment by leaders of the German chemical industry ultimately grew into an attitude of trust which was quite exceptional. It was this which enabled him to become instrumental in establishing the Kaiser-Wilhelm-Institut für Chemie, a research foundation independent of teaching duties inaugurated in 1912. A pronounced individualist, he trusted personalities more than organisations and wisdom more than learning, his own kindling personality and clear wisdom being freely applied to the furtherance of scientific method, both industrial and academic.

It is not difficult to imagine the demands which were made upon him during the war period, the five years which were destined to be his last. In a directive capacity he was associated with many of the commissions charged with solving chemical problems connected with the great conflict, but it was the food shortage which engrossed his attention most urgently. There is no doubt that these labours and their fruitless issue preyed too heavily upon a constitution undermined by lifelong over-application to exhausting labour, and in view of the great age attained by his father, who passed the ninety-fourth year, his own demise was premature in every sense.

Even when due allowance has been made for the storehouse of accumulated facts upon which the chemists of his era were empowered to draw and for the variety of technique which was at their command, it can scarcely be claimed that in wealth of revelation and manipulative skill Emil Fischer is eclipsed by any of his predecessors. It is difficult to imagine that he can be surpassed by any of his successors, but whether this be so or not, his achievement will remain for all time a monument of industry, a masterpiece of symmetry, and a gospel of inspiration.

The Physics and Chemistry of Colloids and their Bearing on Industrial Questions.

THE Faraday and Physical Societies held a joint discussion on "The Physics and Chemistry of Colloids and their Bearing on Industrial Questions" on October 25 in the spacious lecture theatre of the Institution of Mechanical Engineers. The societies were extremely fortunate in having the subject introduced by Prof. Theodor Svedberg, of the University of Upsala, who gave an excellent *résumé*, mainly from the physical point of view, of the present state of knowledge of the subject of colloids on the theoretical side. Prof. Svedberg's written contribution included an excellent bibliography of the subject, which will be found most helpful to physicists and others who wish to become acquainted with modern theoretical developments. The ensuing discussion was divided into the following five sections: (1) "Emulsions and Emulsification," opened by Prof. F. G. Donnan; (2) "The Physical Properties of Elastic Gels," opened by Mr. E. Hatschek and Prof. H. R. Procter; (3) "Glass and Pyrosols," opened by Sir Herbert Jackson; (4) "Non-aqueous Systems," opened by Sir Robert Robertson; and (5) "Precipitation in Disperse Systems: Cataphoresis and Electro-endosmose," opened by Prof. A. W. Porter.

In section (1) the discussion centred mainly around the important problem of the reversal of phases in emulsions produced by electrolytes. The results of experiments on soap emulsions carried out by Mr. S. S. Bhatnagar at University College, London, were given by the author, who concluded that there was a strict parallel between the reversal of phases in emulsions and the precipitation of suspensions by electrolytes. Apart from the considerable theoretical interest attaching to the subject, the matter is of practical importance in that it is closely associated with the action of soaps as protective colloids, to which property it appears probable their detergent nature is due. The speakers were unanimous in affirming the efficiency of the electrical method, first suggested by Clayton (Brit. Assoc. Colloid Reports, No. 2, p. 114, 1918), of ascertaining the point at which phase reversal takes place. A matter of considerable importance referred to by Prof. W. C. McC. Lewis, and agreed to by other speakers, was the necessity when studying the effects of electrolytes on colloids of employing solutions possessing the same conductivity rather than those of identical molar concentrations.

The discussion on the physical properties of elastic gels revealed how scanty is the present state of our knowledge of the mechanism of gel formation and the importance of further research in this direction. Mr. Hatschek emphasised the importance of an extended study of the mechanical properties of gels, which hitherto had been confined precticallv to gelatin, in which chemical complications may arise. A much more promising field presented itself in non-aqueous systems, *e.g.* vulcanised rubber in benzene. In an investigation into the mechanical properties of gelatin Mr. Hatschek had obtained the astonishing result that, after straining a rectangular prism of 10 per cent. gelatin gel for five days, not only had the stress practically disappeared, so that on removing the constraint the strain remained, but the optical anisotropy remained after removal of the stress.

Prof. Procter, in advocating his well-known solid-solution theory—which, he explained, differed from the sponge-like structure theory mainly on the question of size—pointed out that the difference was not unimportant, since microscopic size of network excludes or complicates the simple chemical causes which are sufficient for the solid-solution view. The opposite view involves a mechanical structure which itself demands explanation. Critics of the solid-solution theory, however, found it difficult to believe that a 1 per cent. agar gel is a solid solution, and Prof. Procter admitted that the case of agar presented great difficulties.

Some very important work relating to gel structure has been carried out in the laboratories of Prof. McBain at Bristol on soap solutions, which in Prof. McBain's opinion excludes the cellular-structure theory. It has been shown in his laboratory that a half-normal solution of sodium oleate could be made to exist in any one of three forms: (*a*) Transparent liquid (sol), (*b*) a jelly (gel), and (*c*) a curd. The sol and gel are absolutely identical in every respect except in mechanical properties. They display identity of Na-ion content, refractive index, osmotic pressure, and conductivity, so that it appears that the particles present are identical in the sol and gel. On the contrary, in the curd form some of the soap separates out into fibrils and the conductivity disappears, this process being analogous to crystallisation. Prof. McBain considered these results to bear out the view of Zsigmondy and others that the particles in both sol and gel exist in micellar form and are linked together in some way analogous to the structure of liquid crystals. An example of the extraordinary character of the sol-gel transformation was brought to notice by Prof. Svedberg. A non-aqueous gel was formed of cadmium in alcohol having a cadmium concentration of only 0·1 per cent., in which the slightest vibration was sufficient to break down the whole structure and change it to the sol state.

Sir Herbert Jackson, in opening up the subject of glass and pyrosols, expressed doubt, except perhaps in some cases of colouring, as to whether glass came within the domain of colloids. With good glasses ordinary methods of illumination failed to reveal the Tyndall phenomenon, this being visible only with very strong illumination. The figures obtained by etching glasses he considered to be merely surface-tension effects, and afforded no evidence whatever of the colloidal nature of glass. In regard to the colouring of glasses much research is needed into the conditions under which various colours are produced. Evidence was adduced by Sir Herbert which makes it appear probable that the colouring substances have specific effects, although pure diffraction effects depending on the sizes of particles undoubtedly exist.

Non-aqueous colloid systems were dealt with under three headings: (*a*) Nitro-cellulose, (*b*) Celluloid, and (*c*) Rubber. Sir Robert Robertson dealt with the colloidal properties of nitro-cellulose gelatinised by means of suitable solvents, which properties have an important bearing on the manufacture of propellants. Useful relationships had been established between the viscosities of solutions of cellulose, those of the resulting solutions of nitro-cellulose, and the mechanical properties of the final dried material. By controlling the viscosities of the solutions the required mechanical properties of the resultant dried nitro-cellulose mixtures were assured. In connection with celluloid the discussion centred largely around the solvent property of binary mixtures, such as ether-alcohol, which is very different from that of the constituents separately. The ether-alcohol complex theory originally put forward by Baker was largely criticised. The discussion on the colloidal properties of rubber was confined practically to a communication by Mr. B. D. Porritt, who, in describing the effects of light on rubber, emphasised the important part played in rubber deterioration by oxygen, both as a catalyst and by direct chemical action. The inclusion of a dye to absorb ultra-violet light helps to prevent the deterioration. Experiments on the sol-gel transformation produced in rubber solutions by light and oxygen were described.

Perhaps the most important paper of the whole discussion, in that it represented a distinct advance in theory, was that by Mr. J. N. Mukherjee in section (5). Starting with the view that the charge on a suspensoid particle is due to adsorption, arising from chemical forces, of the ion the particle has in common with the peptising or stabilising electrolyte, Mr. Mukherjee has deduced a relation between the "electrical adsorbability" of the oppositely charged ion of the precipitating electrolyte and its valency and mobility. This theory not only results in the same series of cations arranged in order of adsorbability as that for the precipitation of negatively charged suspensoids, but also agrees extremely well with the most trustworthy experimental results on electro-endosmose.

On the whole, it may be said that the discussion centred around the physical properties of colloids rather than around their industrial applications, which are complex. Advancement in our knowledge of colloids can be made only by simplifying experimental conditions as much as possible, and thence building up step by step to the more complex cases. The full report of the discussion will be published in due course by the Department of Scientific and Industrial Research, and should be read by all those who are interested in this fascinating subject.

University and Educational Intelligence.

BRISTOL.—At Congregation held on October 22 the honorary degree of M.A. was conferred on Mr. Avery Adams, who has held the office of secretary to the Bristol Education Committee for thirty-three years; Mr. G. H. Burkhardt, head of the North Wilts Secondary School and Technical Institution; and Mr. W. A. Knight, head of Sexey's School at Bruton, Somerset.

CAMBRIDGE.—The trustees of the Capt. Scott Memorial Polar Research Trust have offered the University a sum of 6000*l.* towards the provision of a suitable wing or annexe to a proposed new school of geography, the special wing to serve as a Polar research institute. There is a prospect of financial help towards the maintenance and upkeep of the institute from the same source. The institute is to act as a centre both for information on Polar matters and for the working up of results, and it is to include a Polar library, a museum of Polar equipment, a collection of biological and geological specimens, and a set of rooms for research work. Cambridge University is chosen for the site of the institute as a centre which has already proved itself friendly to such research; it contains a nucleus of Polar men able to use and take a keen interest in the department, and is likely to continue to produce men equipped with the necessary knowledge and spirit for further work in Polar regions. An appeal will shortly be issued for funds to endow the larger building required for geographical studies.

A committee at Cambridge has collected a fund to commemorate Sir James Frazer's great services to learning. It is proposed to endow a Frazer lectureship in social anthropology, the lecture to be given annually in rotation at Oxford, Cambridge, Glasgow, and Liverpool.

It is proposed to make Dr. Duckworth, of Jesus College, reader in human anatomy. Dr. T. J. I'A. Bromwich, of St. John's College, has been re-appointed University lecturer in mathematics. Prof. J. T. Wilson has been elected a fellow of St. John's College.

The vote on the proposed statute admitting women to membership of the University has been fixed for December 8.

MAJOR DAVID DAVIES, M.P., has given 12,500*l.* to found a chair of tuberculosis at the Welsh National Medical School, University of Wales.

FOUR free lectures on "Four Great Geometers" (Archimedes, Galileo, Newton, and Clerk Maxwell) are announced for delivery by Mr. W. D. Eggar at Gresham College, Basinghall Street, E.C.2, on November 16–19. The lecture hour is 6 o'clock.

THE sum of 425,000*l.* has been stated by Mr. H. A. L. Fisher, President of the Board of Education, in reply to a question in Parliament, to be the price which the Duke of Bedford and his trustees have agreed to accept for the Bloomsbury site offered by the Government to the Senate of the University of London.

NOTICE is given by the University of London of the award in 1921 of the 100*l.* Rogers prize, the subject for which is "Hyperthyroidism and its Surgical Treatment." Copies of the regulations governing the competition and information as to the date on which the essays must be received can be obtained from the Academic Registrar, University of London, South Kensington, S.W.7.

VISCOUNT HALDANE will deliver an address entitled "The Nationalisation of Universities" at a reunion of old students of the Royal College of Science on Tuesday next, November 9, at the Imperial College Union, Prince Consort Road, South Kensington, London, S.W.7. The president of the Old Students' Association, Sir Richard Gregory, will take the chair at 8 p.m. The address will be followed by discussion.

THE prospectus of the courses to be held at the Municipal College of Technology, Manchester, during the year 1920–21 has been issued. Full-time courses extending over three years, which lead to certificates and degrees, are provided in mechanical, electrical, and sanitary engineering, and in the chemical and textile industries. Another feature of the college is the provision of part-time day courses for engineers' and other apprentices whose employers allow them to devote one whole day per week to study. Part-time evening courses which extend over five years are also given for the purpose of training men for responsible posts in industrial affairs. Research and advanced study receive attention, and students are prepared in part-time classes for degrees at Manchester and London in natural and technological sciences. A new degree of Doctor of Philosophy has been instituted with the object of encouraging research; candidates for this degree must be graduates of a university who have pursued an approved course of advanced study or research in Manchester University for a period of at least two years, of which not more than one year may be spent in another approved institution. Details of the full-time courses are given, but for particulars of the part-time classes application should be made to the Registrar for the prospectus of the department concerned.

ON September 29 the executive of the Engineering Training Association met, by authority of the council of that body, to consider the transference of the work of the association to the Federation of British Industries or to the Engineering and National Employers' Federations. Representatives of these different bodies were present, and outlined the motives which induced their respective organisations to make the offer. Mr. Richmond, on behalf of the Engineering and National Employers' Federations, stated that the chief reason for his society's offer was the increasing frequency and the greater importance of training questions which occur in the agenda of the federation's conferences with Labour. Until now they had been satisfied with the work of the Engineering Training Association, but they felt that as the latter body was about to cease to be an independent unit they were in the best position to carry on its work without interfering with that of other organisations. Mr. Prescott, speaking for the Federation of British Industries, said that they were prepared to carry on the work of the Engineering Training Association if they were asked to do so, or to stand aside if they felt satisfied that the work would be done properly by someone else. The co-ordination of industrial education was part of the work of his body, but if he could receive assurances that the Engineering and National Employers' Federations would keep the educational section of the Federation of British Industries fully informed, and that the two societies would co-operate in the fullest possible way, he would be glad to withdraw the offer of the latter in favour of the Employers' Federation. After a discussion the executive of the Engineering Training Association decided to accept the offer of the Engineering and National Employers' Federations, and details of the transfer were delegated to the honorary organiser, Mr. A. E. Berriman.

Societies and Academies.

PARIS.

Academy of Sciences, October 11.—M. Henri Deslandres in the chair.—The president announced the death of Prof. Yves Delage.—G. **Bigourdan**: Corrections of the normal time-signals emitted by the Bureau international de l'Heure from January 1 to March 19, 1920. Two tables give corrections of the ordinary partly automatic signals and of the beats 1 and 300 of the scientific signals.—Y. **Delage**: The application of the Pitot tube to the determination of the velocity of ships and to the registration of the distances traversed. The Pitot tube has been much used for the determination of fluid velocities with respect to immersed solid objects; it can also be utilised to determine the velocity of an object moving in still water, and its application to the measurement of the speed of a vessel is described in the present communication. Various devices are given for working the indicator at a distance from the Pitot tube, for rendering the indications independent of the variations of the load of the vessel, and for arranging that the movements of the needle shall be proportional to V and not to V^2, so that from the continuous curve the total distance traversed can be estimated.—C. **Moureu** and G. **Mignonac**: The dehydrogenation of alcohols by catalytic oxidation under reduced pressure. The general method described in a previous paper for the preparation of aldehydes and ketones by the catalytic oxidation of the corresponding alcohols by air in presence of reduced silver gives excellent results for the alcohols of low molecular weight, but the yield diminishes as the molecular weight of the alcohol increases. By working under reduced pressure (20 mm. to 40 mm.) this difficulty is removed.—P. **Termier**: The mylonites of the fourth Briançon *écaille*.—The secretary announced the death of M. Daniel Pauline Œhlert, correspondant for the section of mineralogy.—A. **Chatelet**: The enumeration and constitution of any Abelian body whatever.—L. **Antoine**: The possibility of extending the homœomorphy of two figures to their vicinity.—J. **Andrade**: Friction and isochronism.—Ch. **Déné**: Waves of shock. The results of the study of a series of photographs of a stationary projectile placed in a stream of air moving at the rate of 450 metres per second. As the secondary waves are stationary, they can be more easily photographed and studied.—W. A. **Loth**: A new method of navigation, permitting any vessel to enter and leave our (French) ports without risk when the usual means of determining the route are missing. An armoured cable traversed by an alternating current with a musical frequency is laid on the sea-floor along the track to be followed, and a telephonic receiving apparatus of special design is carried by the entering vessel. One person without specialised knowledge can bring in a ship, as has been shown by practical trials at Brest.—R. **Dubrisay**: The application of a new method of physico-chemical volumetry. The solutions under examination are mixed with an equal volume of phenol and the temperature of miscibility is determined. The method has been applied to the study of mixtures of solutions of sulphuric acid and sodium hydroxide, and two angular points are shown on the experimental curve corresponding to the formation of $NaHSO_4$ and Na_2SO_4. It is noteworthy that when the neutralisation curve of sulphuric acid is followed by electrical conductivity or by cryoscopy no point corresponding to the formation of $NaHSO_4$ is detected.—P. **Bugnon**: Causes of the transversal course of the libero-ligneous bundles at the nodes of the Gramineæ.—C. **Beau**: The trophic *rôle* of the endophytes of orchids.—G. **Astre**: The biology of the molluscs in the French coast dunes and its relations with botanical geography. A discussion of the distribution of molluscs as affected by varying conditions of dryness. Apart from some secondary modifications of minor importance, the malacological fauna of the dunes is not one which has evolved in view of adaptation to a special medium, but a fauna already preadapted on the Mediterranean coasts, and which has simply extended its area of distribution.—P. **Wintrebert**: The aneural conduction of the ectoderm in the embryos of Amphibians.—M. **Caullery** and F. **Mesnil**: The existence of asexual multiplication in certain Sabellians (*Potamilla Torelli* and *Myxicola dinardensis*).—L. **Besson**: Relations between the meteorological elements and the number of deaths through inflammatory diseases of the respiratory organs in Paris. The data covered 522 weeks, and showed a clear relation between the number of deaths and the mean temperature three weeks before. From 0° C. to 14° C. the fall in the number of deaths was proportional to the rise in temperature. Above 20° C. the deaths remained constant and independent of the temperature.

HOBART.

Royal Society of Tasmania, September 13.—Mr. L. Rodway, vice-president, in the chair.—Dr. W. L. **Crowther**: The Tasmanian aborigines. The general habits of the race were traced and the osteology of the aborigines was described.—H. H. **Scott** and C. **Lord**: *Nototherium Mitchelli.* The apendicular skeleton, including the mamus and pes (hitherto unknown). The paper dealt in detail with the osteological formations of the feet of the Nototheria. After describing in detail the various characteristics of these and other portions of the specimen under review, the authors append various recapitulative notes on their studies to date. In the course of these they point out that their aim has been to show that the rhinoceros type was not absent from the fauna of Australia in ages past. True to the structural type of the country, the animals retained the marsupial habit, simply grafting on to it the results of that evolutionary trend that has culminated in other lands in the Perissodactylan lengulates. For the scientific use of the skeleton of *Nototherium Mitchelli* the authors are indebted to Mr. K. M. Harrisson, of Smithton, who generously placed the specimens at their disposal for the purpose named. Mr. Harrisson has also presented the whole of the remains to the Tasmanian Museum, Hobart, with a view to their future exhibition in that institution.—W. L. **Crowther** and C. **Lord**: A descriptive catalogue of the osteological specimens relating to *Homo tasmanensis* contained in the Tasmanian Museum. For their introductory remarks the authors state that during the course of the preparation of a paper dealing with certain recent valuable additions to the Tasmanian Museum it became necessary to revise the complete collection of the osteological specimens relating to the Tasmanian aboriginals. The present list forms a record of the largest single collection of osteological remains of the extinct Tasmanian aboriginals. The main portion of the paper deals with 361 osteological specimens relating to the Tasmanian aboriginals, each bone being described.

Books Received.

Recent Advances in Physical and Inorganic Chemistry. By Prof. A. W. Stewart. Fourth edition. Pp. xvi+286+v plates. (London: Longmans, Green and Co.) 18*s*. net.

Aeronautics in Theory and Experiment. By W. L. Cowley and Dr. H. Levi. Second edition. Pp. xii+331+plates. (London: E. Arnold.) 25*s*. net.

Spiritualism and the New Psychology. By M. Culpin. Pp. xvi+159. (London: E. Arnold.) 6*s*. net.

Recueil de l'Institut Botanique Léo Errera. Tome iv. Pp. xi+653+plates. 50 francs. Tome x., Fasc. 1. Pp. 80. (Bruxelles: M. Lamertin.)

Imperial Institute. Indian Trade Inquiry. Reports on Rice. Pp. ix+164. (London: J. Murray.) 6*s*. net.

Diagnosis and Treatment of Brain Injuries with and without a Fracture of the Skull. By Prof. W. Sharpe. Pp. vii+757. (Philadelphia and London: J. B. Lippincott Co.) 35*s*. net.

The Wild Unmasked. By F. St. Mars. Pp. 376. (London and Edinburgh: W. and R. Chambers, Ltd.) 6*s*. net.

Obstetrics: Normal and Operative. By Prof. G. P. Shears. Third edition. Pp. xxii+745. (Philadelphia and London: J. B. Lippincott Co.) 35*s*. net.

Habits and Characters of British Wild Animals. By H. M. Batten. Pp. 346. (London and Edinburgh: W. and R. Chambers, Ltd.) 21*s*. net.

An Account of the Crustacea of Norway. By G. O. Sars. Vol. vii.: Copepoda. Supplement, parts iii. and iv.: Harpacticoida (continued). Pp. 25–52+xvii–xxxii plates. Parts v. and vi.: Harpacticoida (continued). Pp. 53–72+xxxiii–xlviii plates. (Bergen: Bergen Museum.)

Anleitung zum Nachweis zur Trennung und Bestimmung der Reinen und aus Glukosiden esw. erhaltenen Monosaccharide und Aldehydsauren. By Dr. A. W. van der Haar. Pp. xvi+345. (Berlin: Gebrüder Borntraeger.) 64 marks.

Die Reaktionen des freien Stickstoffs. By Prof. W. Moldenhauer. Pp. viii+178. (Berlin: Gebrüder Borntraeger.) 26 marks.

The Chemistry of Crop Production. By Prof. T. B. Wood. Pp. vii+193. (London: University Tutorial Press, Ltd.) 5*s*. 6*d*.

A Dictionary of Scientific Terms. By I. F. Henderson and Dr. W. D. Henderson. Pp. viii+354. (Edinburgh and London: Oliver and Boyd.) 18*s*. net.

Bio-Moulding Origins in Evolution. By Dr. H. Elliot-Blake. Pp. 140. (London: J. G. Hammond and Co., Ltd.)

The Serbian Epidemics of Typhus and Relapsing Fever in 1915. By Col. W. Hunt. Pp. 29–158. (London: J. Bale, Sons and Danielsson, Ltd.) 7*s*. 6*d*. net.

Notes on Geological Map-Reading. By A. Harker. Pp. 64. (Cambridge: W. Heffer and Sons, Ltd.) 3*s*. 6*d*. net.

Betty and Bobtail at Pine-Tree Farm. By Lilian Gask. Pp. 224. (London: G. G. Harrap and Co., Ltd.) 6*s*. net.

Physiology. By Dr. F. Roberts. Pp. viii+380. (London: J. and A. Churchill.) 15*s*. net.

Instinct and the Unconscious. By Dr. W. H. R. Rivers. Pp. viii+252. (Cambridge: At the University Press.) 16*s*. net.

Department of Applied Statistics, University of London, University College. Questions of the Day and of the Fray, No. X. The Science of Man: Its Needs and its Prospects. By Prof. K. Pearson (Presidential Address to Section H of the British Association, Cardiff.) Pp. 17. (London: Cambridge University Press.) 1*s*. 6*d*. net.

Islands Far Away. By Agnes G. King. Pp. xxvii+256. (London: Sifton, Praed and Co., Ltd.) 18*s*. net.

Classification des Sciences: Les Idées Maitresses des Sciences et leurs Rapports. By Prof. A. Naville. Troisième édition. Pp. iii+322. (Paris: F. Alcan.) 10.50 francs.

Tools and Weapons: Illustrated by the Egyptian Collection in University College, London, and 2000 Outlines from other Sources. By Prof. W. M. Flinders Petrie. Pp. vii+71+lxxix plates. (London: Constable and Co., Ltd.; B. Quaritch.) 35*s*. net.

The General Principle of Relativity: In its Philosophical and Historical Aspect. By Prof. H. Wildon Carr. Pp. x+165. (London: Macmillan and Co., Ltd.) 7*s*. 6*d*. net.

Laboratory and Field Exercises for "General Botany." By Prof. H. D. Densmore. Pp. viii+199. (Boston and London: Ginn and Co.) 3*s*. 9*d*. net.

Medical Electricity. By Dr. H. L. Jones. Eighth edition, revised. Pp. xv+575. (London: H. K. Lewis and Co., Ltd.) 22*s*. 6*d*. net.

Samuel Hartlib: A Sketch of his Life and his Relations to J. A. Comenius. By Dr. G. H. Turnbull. Pp. viii+79. (London: Oxford University Press.) 5*s*. net.

The British Academy. International Scholarship. Presidential Address delivered at the Annual Meeting of the British Academy, July 21, 1920. By Sir F. G. Kenyon. Pp. 14. (London: Oxford University Press.) 1*s*. 6*d*. net.

This Wonderful Universe. A Little Book about Suns and Worlds, Moons and Meteors, Comets and Nebulæ. By Agnes Giberne. New illustrated edition, completely rewritten. Pp. x+182. (London: S.P.C.K.; New York: The Macmillan Co.) 6*s*. 6*d*. net.

The Nature of Animal Light. By Prof. E. N. Harvey. Pp. x+182. (Philadelphia and London: J. B. Lippincott Co.) 10*s*. 6*d*. net.

Diary of Societies.

THURSDAY, NOVEMBER 4.

ROYAL SOCIETY, at 4.30.—Prof. H. Lamb: The Vibrations of an Elastic Plate in Contact with Water.—Prof. H M. Macdonald: The Transmission of Electric Waves around the Earth's Surface.—Lord Rayleigh: A Re-examination of the Light scattered by Gases in respect of Polarisation. II. Experiments on Helium and Argon.—Prof. C. F. Jenkin: Dilatation and Compressibility of Liquid Carbonic Acid.—W. T. David: Radiation in Explosions of Hydrogen and Air.—Dr. R. E. Slade and G. I. Higson: Photochemical Investigations of the Photographic Plate.—Dr. E. H Chapman: The Relationship between Pressure and Temperature at the same Level in the Free Atmosphere.—Prof. J. C. McLennan: Note on Vacuum Grating Spectroscopy.

SOCIETY OF ENGINEERS (Inc.) (at Burlington House), at 5.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. R. C. B. Wall: Chorea (Bradshaw Lecture).

LINNEAN SOCIETY, at 5.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Wing Comdr. Flack: The Human Machine in Relation to Flying.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.45.—Dr. C. F. Sonntag: The Action of Baths on the Skin and Nervous System.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Mrs. S. S. Brierley: Discussion on Vocational Tests.

CHEMICAL SOCIETY, at 8.—L. Higginbotham and H. Stephen: The Preparation of 4-, 5-, and 6-Methyl-coumarin-2-ones, and some Derivatives of *o*-, *m*-, and *p*-Tolyloxyacetic Acids.—H. Stephen:

A New Method for the Preparation of 2:4-Dihydroxy- and 2:4:4'-Trihydroxy-benzophenone, and some Observations relating to the Hoesch Reaction.—W. J. Pope and E. E. Turner: Triphenylarsine and Diphenylarsenous Salts.—R. H. Atkinson, C. T. Heycock, and W. J. Pope: The Preparation and Physical Properties of Carbonyl Chloride.—H. W. Bausor, C. S. Gibson, and W. J. Pope: Interaction of Ethylene and Selenium Monochloride.—G. Van B. Gilmour: A Study of the Reactions of Sugars and Polyatomic Alcohols in Boric Acid and Borate Solutions, with some Analytical Applications.—F. L. Pyman and L. A. Ravald: The Sulphonation of Glyoxalines.—F. L. Pyman and L. A. Ravald; o- and p-Tolueneazoglyoxalines.—M. E. Laing and J. W. McBain: Investigation of Sodium Oleate Solutions in the Three Physical States of Curd, Gel, and Sol.—J. C. Irvine and E. S. Steele: The Constitution of Polysaccharides. Part I. The Relationship of Inulin to Fructose.—B. E. Hunt: The Preparation of Ethyl Iodide.—R. C. Menzies: Action of Sulphur Trioxide on Aromatic Ethers.—G. T. Morgan and H. D. K. Drew: Researches on Residual Affinity and Co-ordination. Part II. Acetylacetones of Selenium and Tellurium.—R. B. Drew: The Formation of 2:3:6-Trinitrotoluene in the Nitration of Toluene.—J. N. E. Day and J. F. Thorpe: The Formation and Reactions of Imino-compounds. Part XX. The Condensation of Aldehydes with Cyanoacetamide.—O. Becker and J. F. Thorpe: The Formation and Stability of Spiro-compounds. Part III. Spiro-compounds from Cyclopentane.—H. Chattopadhyaya and P. C. Ghosh: Condensation of Dimethyldihydroresorcin with Aromatic Aldehydes.—E. B. Maxted: The Influence of Lead on the Catalytic Activity of Platinum.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—J. D. Barris and M. Donaldson: Acute Inversion of the Uterus. Treatment by Blood Transfusion and Late Replacement.—Drs. R. A. Hendry, A. Routh, and J. Adams: Latent Syphilis During Pregnancy.

FRIDAY, NOVEMBER 5.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science), at 2.30.—Prof. F. W. Oliver: The Reclamation of Waste Land by Botanical Means.—Dr. E. J. Russell: The Reclamation of Waste Land by Agricultural Means.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 4.

GEOPHYSICAL COMMITTEE (Royal Astronomical Society), at 5.—Discussion on the African Arc and Meridian, to be opened by Col. H. G. Lyons, and continued by Sir Charles Close, Col. E. M. Jack, A. R. Hinks, C. G. T. McCaw, and others.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (at the Patent Office Library), at 5.30.—E. W. Hulme: Introduction to the Literature of Historical Engineering.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Sir Richard T. Glazebrook: Limit Gauging (Thomas Hawksley Lecture).

JUNIOR INSTITUTION OF ENGINEERS (at Caxton Hall), at 8.—E. Cooper: Some Further Locomotive History.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Dr. D. W. Buxton: The Psychology of Anæsthesia.

MONDAY, NOVEMBER 8.

BIOCHEMICAL SOCIETY (at Imperial College of Science).

ROYAL SOCIETY OF MEDICINE (War Section), at 5.30.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Meeting), at 7.—C. Poole: Electric and Hydraulic Elevators.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Annual Presidential Address.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street), at 8.—Dean W. R. Inge: Is the Time Series Reversible? (Presidential Address).

SURVEYORS' INSTITUTION, at 8.—J. Wilmot: Presidential Address.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Brig.-Gen. The Hon. C. G. Bruce: Mount Everest.

MEDICAL SOCIETY OF LONDON (at 11 Chandos Street, W.1), at 8.30.—Clinical Meeting.

TUESDAY, NOVEMBER 9.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. E. G. Browne: Arabian Medicine after Avicenna (FitzPatrick Lecture).

SOCIOLOGICAL SOCIETY (at 65 Belgrave Road, S.W.1), at 5.15.—Mrs. V. Branford: Theology and Sociology.

MINERALOGICAL SOCIETY (at Geological Society), at 5.30.—(Anniversary Meeting.)—Dr. E. S. Simpson: A Graphic Method for the Comparison of Minerals with Four Variable Components forming Two Isomorphous Pairs.—L. J. Spencer: Fibrolite (= Sillimanite) as a Gem-stone, from Burma and Ceylon.—Dr. J. W. Evans: The Origin of the Alkali Rocks.—A. F. Hallimond, with an analysis by J. H. Whiteley: Monticellite, from a Mixer Slag.—Dr. H. H. Thomas and A. F. Hallimond: A Refractometer for the Determination of Liquid Mixtures.

ROYAL PHOTOGRAPHIC SOCIETY, at 7.—Presidential Address.

OLD STUDENTS' ASSOCIATION OF THE ROYAL COLLEGE OF SCIENCE (at Imperial College Union, South Kensington), at 8.—Viscount Haldane: The Nationalisation of Universities.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Dr. W. H. R. Rivers: The Origin of Hypergamy.

ROYAL SOCIETY OF MEDICINE (Psychiatry Section), at 8.30.—Dr. E. F. Buzzard: Some Aspects of Mental Hygiene (Presidential Address).

WEDNESDAY, NOVEMBER 10.

ROYAL SOCIETY OF MEDICINE (Surgery: Proctology Sub-section), at 5.30.—E. Miles: Presidential Address.—L. Mummery: The Operative Treatment of the Prolapse of the Rectum in Adults.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.—J. H. S. Dickenson: Some Notes on the Report of the Steel Research Committee.

THURSDAY, NOVEMBER 11.

ROYAL SOCIETY, at 4.30.—*Probable Papers*:—Dr. W. G. Ridewood: The Calcification of the Vertebral Centra in Sharks and Rays.—Dr. A. Compton: Studies in the Mechanism of Enzyme Action. I. *Rôle* of the Reaction of the Medium in fixing the Optimum Temperature of a Ferment.—C. H. Kellaway: The Effect of certain Dietary Deficiencies on the Suprarenal Glands.—E. J. Collins: The Genetics of Sex in *Funaria hygrometrica*.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Annual General Meeting.

ROYAL SOCIETY OF MEDICINE, at 5.—Sir Almroth Wright: Medical Research.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. E. G. Browne: Arabian Medicine after Avicenna (FitzPatrick Lecture).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir D'Arcy Power: The Education of a Surgeon under Thomas Vicary (Thomas Vicary Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Ll. B. Atkinson: Inaugural Address.

OPTICAL SOCIETY, at 7.30.—Major E. O. Henrici: The Use of Internal Focussing Telescopes for Stadia Surveying.—Dr R. J. E. Hanson: Visual Fatigue and Eye Strain in the Use of Telescopes.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Dr. H. Head and Others: Discussion on Aphasia.

FRIDAY, NOVEMBER 12.

INSTITUTE OF CHEMISTRY, at 4.—To Receive Report of the Extraordinary General Meeting of October 28 and confirm the Resolutions and By-laws passed thereat.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—Dr. F. S. Goucher: Ionisation and Excitation of Radiation by Electron Impact in Helium.—J. Guild: Fringe Systems in Uncompensated Interferometers.—J. Guild: The Location of Interference Fringes.—Dr. G. Barr: A New Relay for Moderately Heavy Currents.

ROYAL ASTRONOMICAL SOCIETY, at 5.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.—Dr. F. Parkes Weber: Chronic Myeloid Leukæmia—Death from Acute Anæmia due to Massive Hæmorrhages (Hæmatomata). Simulation of Slight Pyuria by Leukæmic Oozing in the Urine.—Z. Cope: Diathragmatic Shoulder Pain.

INSTITUTION OF MECHANICAL ENGINEERS, at 7.—Informal Meeting.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—Dr. J. Taylor: Some Neurological Aspects of Ophthalmic Cases (Presidential Address).—P. Smith: The Blood-vessels in the Eye of the Ox.

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NATURE

THURSDAY, NOVEMBER 11, 1920.

Editorial and Publishing Offices:
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Superannuation of University Teachers.

AN inquiry is being made by the Council of the Federated Superannuation System for Universities as to "what capital sums would be involved to place senior members of the staffs of university institutions in receipt of Treasury grants in a position comparable with that they would have enjoyed had the federated scheme been in operation during the tenure of their university appointments." This inquiry has been authorised by the Treasury through the University Grants Committee. It may not be generally known, however, that the suggestion arose in the Council of the Federated Superannuation System, and the authorisation simply means that the Treasury is paying the expenses involved in the inquiry. No doubt by this time the staffs of the various university institutions have received copies of the relative form of inquiry with a request to fill in certain particulars, and most of them will not require to be told that the simplicity of the questions has no obvious relation to the difficulty of answering them.

We fear that the services of the psycho-analyst will have to be requisitioned if retrospective particulars regarding salaries are to be given with any degree of accuracy. In point of fact, we seriously doubt whether these particulars can be given with the necessary degree of accuracy; if some other principle is not adopted, the inquiry might easily develop into a farce. Apart from this, however, two facts emerge—(1) the ambiguity in the use of the term *senior*, and (2) the restricted use of the term *service*. If we are to suppose that one section of university teachers is to be considered in respect of retrospective benefits, and another not, it is perfectly clear to anyone who really understands the temper of university teachers that the University Grants Committee and the Treasury are asking for trouble. Where is the line to be drawn? Why, indeed, should it be drawn? If retrospective benefits are to be given to one, they should be given to another. The School Teachers (Superannuation) Act makes no such distinction in respect of its beneficiaries. The framers of that Act had no desire to bring a hornet's nest about their ears! To draw any such line between one set of university teachers and another, or to limit the retrospective benefits to a certain number of years or to those in receipt of salaries above a certain figure, would be manifestly unjust, and will inevitably lead to criticism and provoke discontent.

Serious as this point is, however, it is not so serious as the question of service. The inquiry is being directed to ascertain the amount of service in universities, constituent colleges of universities, and university colleges, the implication being that no service outside such institutions is to count for retrospective benefits. If this is what is meant, and it is difficult to interpret the inquiry in any other sense, a grave injustice will be done to a not inconsiderable number of university teachers at the present moment, and a distinct injury will be inflicted upon the universities in the future. According to this interpretation, a university teacher who has at some time or other of his career seen service in a school—elementary or secondary—or in a college of non-university rank, will not be allowed to calculate such service as pensionable in respect of retrospective benefits. Surely this is a very absurd position of affairs. As for the future, if the same principle operates, one of the bridges, and a very important one, connecting the schools with the universities will be broken down. If, for example, a teacher spends the whole of his career in a school, or the whole of it in a university, he will receive full pension benefits; but if he is so unfortunate as to spend part of his career in a school or technical college of non-university rank before becoming a university teacher, he is to be mulcted of some portion of his pension benefits. This being so, a barrier is set up, and not only the schools suffer, but also the universities.

The position is quite indefensible. The Council of the Federated Superannuation System, the primary function of which should be the conservation and the extension of pension benefits to university teachers, ought to recognise this. If our understanding of the position is correct, the council may rest assured that university teachers will not be content to remain passive under such an anomalous scheme. We may remind our readers that the conference of representatives of universities and colleges which waited upon the Chancellor of the Exchequer on June 17 last presented the following resolution to him: "That this conference is of opinion that the interests of English and Welsh education as a whole demand the institution of a scheme of superannuation for university teachers and administrative officials conferring benefits not inferior to those granted under the School Teachers (Superannuation) Act, 1918, and of a like retrospective character." This, we understand, is the absolute minimum which university teachers demand; if anything beyond this is granted, they are willing to pay for the additional benefits. They believe that their services, to say the least, are no less valuable to the State than the services of those who benefit under the Act, and that they should receive treatment no whit inferior. Their treatment under existing conditions is enough to rouse the righteous indignation of every just citizen. We had before us recently the case of a university professor who was compelled to retire on account of ill-health, after having taught for more than thirty years. All that he can receive from the Federated Superannuation System is a lump sum of 780*l.*, whereas had he been a teacher eligible for a grant under the Superannuation Act he would be entitled to a superannuation allowance of five-eighths of his average salary for the last five years of service, which would amount to a pension of 240*l.* per annum, and in addition he would have a gratuity of 640*l.* This is a typical case, and it would be easy to give many similar examples of manifest injustice to university teachers.

The suggestion that by receiving equal benefits they will put the yoke of State control round their necks is unworthy of the acumen of the Chancellor of the Exchequer. Already the universities receive an annual grant of 1,500,000*l.* (the total Education Vote this year is about 52,000,000*l.*), and yet they are not State-controlled. Is it conceivable that a Government for an addition of one-twentieth of the university grant—for this is approximately the annual amount that would be required to give university teachers similar benefits to those under the Teachers (Superannuation) Act—will demand State control of the universities? Why has the Government not demanded it up to now? Simply because it has the prescience to recognise that State control of the universities would be fatal to the highest development—intellectual, social, and industrial—of the community. The Chancellor of the Exchequer himself in his remarks to the conference expresses a doubt as to whether "it is an exaggeration to say that what did as much for the ruining of Germany as anything was the lack of independence and the lack of independent power of speech and thought by the teachers of the youth of Germany through all the branches." Is it likely that the Government, as a *quid pro quo* for a comparatively small addition to the annual grant, would propose to deprive the universities of their freedom when highly placed statesmen speak such language? Most unlikely! Is it likely, indeed, that the universities would submit to State control? In our opinion, the bogey of State control of universities as conjured up by Mr. Chamberlain is unthinkable. We begin to wonder what other argument will be adduced to support an absolutely untenable position.

One other fact remains to be stated. The Association of University Teachers, comprising some fifteen hundred full-time teachers in the universities and institutions of university rank in England and Wales, co-operated in the conference referred to above, and supported it in its demand. As a result of the failure of the deputation to the Chancellor of the Exchequer, it immediately instituted a postcard vote amongst its members, setting forth three alternative proposals. Seventy per cent. of the voters declared in favour of the extension of the School Teachers (Superannuation) Act to university teachers, and in consequence the executive has decided to adopt this as its superannuation policy. Here we have a significant fact. If the Council of the Federated Superannuation System, the University Grants Committee, and the Treasury are wise, they will ponder carefully over this indication of the direction in which the university teachers are moving.

Biology of Endogamy and Exogamy.

Inbreeding and Outbreeding: Their Genetic and Sociological Significance. By Dr. E. M. East and Dr. D. F. Jones. (Monographs on Experimental Biology.) Pp. 285. (Philadelphia and London: J. B. Lippincott Co., 1919.) Price 10*s.* 6*d.* net.

IT has been shown that close inbreeding of good stock, if associated with the usual common-sense elimination of wasters, may be persisted in for several generations without any undesirable consequences. Many fine breeds of animals and races of plants have had very close inbreeding at their beginnings. It is said that there is habitual endogamy among bees and ants, and we know that in some formicaries the females are inseminated without an outside excursion. It seems then that "inbreeding is not in itself harmful." This is the first conclusion that the authors of this excellent monograph reach.

One can go further, however, and maintain that close mating is positively advantageous. It fixes desirable characters and leads towards the establishment of a uniform and stable herd. But it is well known that this is only half the truth; there is sometimes an advance, but there is often a disappointing regression—a reduction of vigour, resisting power, fecundity, and even size. Thus the authors tell us that in the case of grain there is a reduction of productivity to perhaps half of what it was, while in the case of maize there is a marked reduction in size and rate of growth. The problem then is to explain the deterioration that sometimes sets in, and to discover whether it is due to the consanguinity as such or to something else.

Drs. East and Jones point out that if there are, to begin with, in the inheritance of the herd, say, four distinct hereditary factors relative to a particular character, such as the colour of the pellage, the automatic effect of the inbreeding will be to isolate four types, each pure as regards the particular character. But some of the characters which are thus segregated may be undesirable "recessives," seldom seen in ordinary circumstances, because they are hidden by their "dominant" allelomorphs. "These recessives are the 'corrupt fruit' which give a bad name to inbreeding, for they are often—very often—undesirable characteristics." "Inbreeding tore aside the mask, and the undesirable characters were shown up in all their weakness, to stand or fall on their own merits." This is an interesting theoretical interpretation, and it immediately suggests a practical application. For if the inbreeding brings to the surface certain characters which were in the general inheritance of the stock, but were kept out of sight by more favourable characters which dominated them, it is open to the breeder to practise stern elimination, to get rid of the "isolated" types with undesirable characters, leaving the stock all the better for its purgation. It need scarcely be said that the authors back up their conclusion with a wealth of experimental data, and that they give it the fit and proper technical formulation.

It is often useful to stand back, as it were, from the realm of organisms and the age-long process of organic evolution, and ask ourselves what the great steps or trends have been. We mean such steps as getting out of the water, substituting sexual for asexual reproduction, and establishing viviparity. Another great trend is the securing of cross-fertilisation, though the range of the cross varies within wide limits. Parthenogenesis has been tried, and it seems to work well enough among Rotifers; autogamy or self-fertilisation has been tried, and it seems to work well enough in the liver-fluke; but the broad fact is that some form of cross-fertilisation is the rule. And if we ask for the deep reason justifying this, the probable answer is that the survival value of cross-fertilisation lies largely in the fact that it promotes variability. It brings about a greater variety of raw material on which selective agencies can operate. Now the authors bring forward experimental evidence to show that the wider ranges of cross-fertilisation which are called outbreeding are valuable in promoting variability, and they have an interesting discussion of the limits of profitable crossing. The strains crossed may easily be too unlike.

But there is another advantage in outbreeding, that it promotes the mysterious quality called "vigour." Darwin was strongly of opinion that the gain in constitution derived from an occasional crossing was a more important biological fact than the loss that sometimes follows close inbreeding; the authors confirm this shrewd judgment. What is the meaning of this "hybrid vigour," which may be associated with increase in resisting power, in size, and in other good qualities? It has been suggested that some physiological stimulus comes to the offspring because of the unlikeness or apartness of the parents, but that is not the authors' view. They think that the reason for "hybrid vigour" is to be found in the pooling of diverse hereditary resources of good quality. The crossing makes it more likely that a *minus* on one side may be made good by a *plus* on the other, or that desirable dominants may corroborate one another.

Sterility is such a puzzling phenomenon that any suggestion from competent biologists is very welcome. The authors point out the striking fact that both inbreeding and outbreeding may land the organism in sterility, and they suggest that there may be two quite different kinds of diverse origin. Inbreeding tends to sort out homogeneous pure strains in a stock, and in this sifting the ability to reproduce may be lost. On the other hand, outbreeding may bring together two germ-cells too incompatible in their chromosomal complex to allow of the continuance of the germ-cell lineage. Thus it may be that the number of chromosomes in horse and ass is too discrepant to allow of fertile progeny.

We have to thank the authors for a valuable monograph, embodying the results of many personal experiments and a critical utilisation of material previously available in the work of others. The book is marked at once by independence and by scholarship. Of great interest to many will be the application of the biological results to the particular case of man. There is a carefully selected bibliography, which might have included perhaps a useful work by Reibmayr, "Inzucht und Vermischung beim Menschen" (1897).

Einstein's Exposition of Relativity.

Relativity: The Special and the General Theory. A Popular Exposition. By Prof. Albert Einstein. Authorised translation by Dr. Robert W. Lawson. Pp. xiii+138. (London: Methuen and Co., Ltd., 1920.) Price 5s. net.

A POPULAR exposition of the doctrine of Relativity and what it implies: for this the world has been crying since the astronomers announced that the stars had proved it true. Here is an excellent translation of Einstein's own book; we hasten to it to know the whole truth and nothing but the truth. The reviewer on this occasion should be the man in the street, the man who, with thousands, has been asking, "What is Relativity?" "What is the matter with Euclid and with Newton?" "What is this message from the stars?" Whether it is possible for the prophet to make his message clear to the multitude, only history can prove. He must needs speak largely in parables, in incomplete similes; and he is subject, therefore, to inevitable misunderstanding.

The plain fact is that Einstein asks the world to give up preconceptions, and to change its point of view. Men jump at suggestions of the fourth dimension, which promise some amusement, and room for a play of fancy. But the fourth dimension does not call for a very high flight of imagination; it is not taken very seriously; it is even recognised as a commonplace and somewhat old-fashioned intellectual pastime. A much more serious trouble comes in with the simple concrete instance. A passenger sitting in a train finds himself hurrying towards the other side of the carriage. He remarks that the brakes have been put on and the train is stopping. We are told that he may also interpret his experience thus: "The carriage remains permanently at rest . . . during the period of application of the brakes, the railway embankment, together with the earth, moves non-uniformly in such a manner that their original velocity in the backwards direction is continuously reduced." This seems to upset all the mechanics we had ever learned. For while we had always been carefully taught that the real explanation of the phenomenon lies in the stopping of the train while we ourselves move on uniformly, it is now held to be indifferent whether we adopt this attitude or think of the pressure of the driver's hand on the brake lever as imparting a change of motion to the whole earth and to ourselves—to everything, in fact, except the train. But the plain man feels there is a very real difference, and the ardent mathematician must indeed be living in an abstract world if he does not feel it too.

Here, indeed, is the great virtue of mathematics, that in it one may escape from the tyranny of gross perception. As Prof. Eddington puts it, the mathematician is never so happy as when he does not know what he is talking about. The engine-driver applying the brake does not know what happens either to the train or to the earth; he does know that he has some control over their relative motion. The mathematician does not know, and does not wish to know, what happens to this or that individual thing. He takes that for granted. He asks only what are the relations between events, or rather what can the mind know about them. Here only the genius can make progress. An unshackled imagination and a keen logical sense must combine in the adventure. The human mind has dared to look upon all history in space and time as laid out before it, and having thus overstepped the limits of mortality, it must go back and ask how much of this vision it may, as mortal, know.

At this moment rain is falling, leaves are rust-ling, a motor hurries along the road, the clouds are drifting. All is change and motion. It seems that all history is change, and all is hurrying by us as we stand. But is it not a truer view, certainly a less egoistic one, to see history as one eternal whole, and ourselves as voyagers through it, our vision of it ever changing? All our experiments, our measurings and comparisons are themselves part of the great web; we ourselves are part and parcel of it, and must acknowledge our incapacity to put ourselves outside. All our pictures and conceptions of the universe in time and space are but pictures, and the painters are many. There are strange differences between their records of what they have perceived—more, indeed, of difference than of similarity. We go to a picture-gallery; there is so much of difference that at first there seems little in common. Yet gradually we become conscious that the pictures are all drawn from a common life. We begin to be able to analyse the painters, and see what kind of a mind is looking out upon it, to detect a point of view. In so doing we grow more clear as to the one reality behind all the pictures.

This is a true parable of the great change that has been consummated in physical thought by Einstein's work. It is the recognition of the relativity of our space-and-time pictures that has clarified our understanding of the universal phenomena. Gravitation has not been explained. The mystery of it is ten times greater than before. To Newton it was one among many properties of that fundamental mystery "matter." It is almost true now to reverse the order and say that matter is one of the manifestations of the fundamental mystery of gravitation.

The reader of Einstein's exposition will need to ponder hard if he is to get to the heart of the matter. For it is a spiritual adventure upon which he has to embark. The very clarity and simplicity of the book may hide this from the over-confident. The parable may be understood and its meaning lost. But to those who have the vision the world of physics will take on a new and wonderful life. The commonest phenomena become organic parts of the great plan. The rationality of the universe becomes an exciting romance, not a cold dogma. The thrill of a comprehensive understanding runs through us, and yet we find ourselves on the shores of the unknown. For this new doctrine, after all, is but a touchstone of truth. We must submit all our theories to the test of it; we must allow our deepest thoughts to be gauged by it. The metaphysician and he who speculates over the meaning of life cannot be indifferent.

The Cambridge British Flora.

The Cambridge British Flora. By Prof. C. E. Moss, assisted by specialists in certain genera. Illustrated from drawings by E. W. Hunnybun. Vol. iii. Portulacaceæ to Fumariaceæ. Text: Pp. xvi+200. Plates: Pp. vi+191. (Cambridge: At the University Press, 1920.) Price, two parts, *6l.* 15*s.* net; two parts in one volume, *7l.* net.

THE previous volume of "The Cambridge British Flora" was reviewed in NATURE of August 6, 1914. Since this review was written many things have happened. Dr. Moss has been appointed professor of botany at the University College, Johannesburg, and has been unable to give personal attention to the volume during its passage through the press. The syndics of the University Press acknowledge valuable assistance given by Mr. A. J. Wilmott, of the botanical department of the British Museum, in correcting proofs and in dealing with questions which are normally settled by an editor. In July, 1918, Mr. E. W. Hunnybun died. A sympathetic note by Mr. Wilmott, at the beginning of the present volume, gives an interesting account of his method of work in preparing the illustrations, which makes clear both its advantages and limitations. The character of the illustrations has been much discussed among British botanists, but it became evident that Mr. Hunnybun could work only on his own lines, the accurate delineation of an individual specimen, and was also unable to supply the botanical details of structure of flower and fruit which, in the opinion of many, would have enhanced the value of the illustrations. As permanence is a consideration in a work of such importance as a standard British Flora, it is surprising to find the plates printed on a chalk-faced paper. Other events have tended to delay the appearance of the present volume, and to cause the serious increase in cost of production, which has necessitated raising the price to nearly three times that of the previous volume. The syndics of the Cambridge University Press must view this addition to their difficulties with grave anxiety, and it is to be feared that many students of our British flora who would wish to possess the book will be unable to meet the increased cost. The critical elaboration of a number of families will be of considerable value should the work fail of completion; but British botanists will feel deeply disappointed if it cannot be carried through satisfactorily.

The families included in vol. iii. are Portulacaceæ, Illecebraceæ, Dianthaceæ (more generally known as Caryophyllaceæ), Nymphæaceæ, Ceratophyllaceæ, Ranunculaceæ, Actæaceæ (comprising the single genus Actæa), Berberidaceæ, Pæoniaceæ (limited to Pæonia), Papaveraceæ, and Fumariaceæ. The genera Montia and Cerastium have been elaborated by Dr. G. C. Druce, several genera of Dianthaceæ by Prof. R. H. Compton, and the genus Fumaria by Mr. H. W. Pugsley. In view of unavoidable delay in publication, it would be an advantage if the dates of completion of the monographs of the various families and genera were given; this would avoid the necessity for explanation in such cases, for instance, as Mr. Pugsley's account of Fumaria, which is antedated in publication by his recent complete monograph of the genus in the Linnean Society's journal, but was probably completed before the more important work was undertaken.

Dr. Moss has intercalated in the text notes on systematic arrangement, limitations of orders and families, and discussions of points of nomenclature, many of which are of considerable interest, though sometimes difficult of appreciation by the ordinary student of British botany, who may, perhaps, consider the elevation of Actæa and Pæonia to the rank of distinct families as puzzling and unnecessary. On the other hand, the student of the British flora will welcome the careful and critical treatment of the genera, species, and varieties of his plants, and appreciate the notes on their respective distribution in Great Britain and Europe, and the discussions as to their indigenousness in doubtful cases. The outline maps indicating distribution are a useful feature, and the information conveyed therein may be supplemented should occasion arise.

It is to be regretted that personal matters should have been introduced into a work of this kind. "The Cambridge British Flora" will, presumably, take rank as a standard work, a presentation of the knowledge and views of eminent British botanists at a certain period in the history of botany, and to perpetuate the differences of opinion which have arisen on matters of very secondary importance detracts from the dignity which such a work should possess. The syndics of the Cambridge University Press would have been well advised if they had exercised a fatherly censorship on several paragraphs in the introduction to the present volume. In conclusion, we would express the hope that the two succeeding volumes, which will carry the work to the end of the family Rosaceæ, will be published with as little delay as possible.

A. B. R.

Man and Matter.

Religion and Science: From Galileo to Bergson. By J. C. Hardwick. Pp. ix+148. (London: S.P.C.K.; New York: The Macmillan Co., 1920.) Price 8*s.* net.

BECAUSE we wish to give a very favourable impression of this little book, we propose to state our criticisms at once, leaving no "but" to the end which might suggest a reservation on the part of the reviewer. Mr. Hardwick has written a very clear account of some of the chief movements of philosophic thought since the Renaissance, in so far as these bear on the concepts of science and of religion, though he modestly disclaims so large a plan. We doubt if the title is well chosen, in spite of its excellent simplicity. "Religion and Science" suggests apologetic, possibly ill-balanced and ignorant, and this the book emphatically is not. Further, the author's definition of science is unduly wide in scope. "Systematic and accurate knowledge about everything there is to be known" (p. 2) really covers the whole of philosophy: science, as the term is commonly understood, deals with the facts of the physical universe alone. Thus the statement that "religion and science regard reality from different angles, but it is the same reality that is . . . the goal of their search" (p. 6), though true for the author's definition, is not true for Prof. Karl Pearson's (which he quotes) or for that of the ordinary man. The statements about radium on p. 126 are condensed to the verge of inaccuracy. Radium is *not* the only element which breaks down; it does *not* evaporate; nor are all the particles into which it disintegrates electrons, as the phrasing suggests. The statement that "electricity is a species of energy which can be expressed in terms of Will" (p. 128) conveys absolutely no meaning as it stands, and suggests that the author has not wholly escaped the plausible but dangerous idea that the dematerialisation of matter to which scientific investigation is tending necessarily brings matter nearer in nature to mind, thus confirming the idealist position.

Philosophers may here and there disagree with the author's emphasis. For example, the contribution of Hegel is generally held to be more important than is here allowed, or at least than is brought out; while the statement of the influence of Kant gives more finality to his work than is perhaps justifiable. But these are all minor blemishes—for the most part verbal—in a valuable book. Though it is far from faultless, we do not remember to have seen so clear, simple, and balanced a summary of the main trends of human thought about the relation between man and the matter amid which he lives and moves.

Few young students of science, and as few clergy, have any clear view of the history of the philosophic thought that bears on their work. We would suggest that the time spent in reading this little book would bring them lasting gain. It is so simple that it will interest those quite untrained in philosophy. It is not technical; it is neither dogmatic nor aggressive; it does not moralise or urge a doctrinal point of view. Furthermore, it is redeemed from the deadliness of most summaries by its admirable clarity and its firm adherence to one path where tempting by-ways cross it. The layman in science and theology will be almost equally attracted, and will rise with whetted appetite; for the defect, or merit, of the book is that one wishes it were longer and fuller. Nevertheless, we believe that Mr. Hardwick has done wisely in keeping his limits so narrow. He might have written a much bigger book, done it equally well, and yet have missed his mark. As it is, we believe that his shot will go home.

S. A. McDOWALL.

Our Bookshelf.

Mrs. Warren's Daughter: A Story of the Woman's Movement. By Sir Harry Johnston. Pp. xi+402. (London: Chatto and Windus, 1920.) Price 7*s.* 6*d.* net.

In writing "Mrs. Warren's Daughter," and more particularly in his first and very successful novel, "The Gay Dombeys," Sir Harry Johnston has sought to reproduce some aspects of the life led by men of science in London during the decades which stretch from last century into the present. Both novels are speculations regarding the influence of environment on human character and action; in "The Gay Dombeys" the author seeks to depict the influence of the post-Darwinian period on the descendants of the Dombey family created by Dickens, and in "Mrs. Warren's Daughter" he gauges the effect of the feminist movement of recent years on the daughter of that rather tarnished lady, Mrs. Warren, placed first on the stage of literature by Mr. George Bernard Shaw. Those, however, who knew the Zoological, Geographical, Anthropological, and other learned London societies some thirty or forty years ago will read these books with a double interest, for they will find that Sir Harry's characters resuscitate past chapters in the history of scientific life in London. The author, it is needless to say, uses a light and nimble pen to draw word-pictures seen from a highly individualistic Harry Johnstonian angle.

In "Mrs. Warren's Daughter" we are introduced to Prof. Michael Rossiter, F.R.S., "a really admirable and fluent lecturer on anthropology, chemistry, ethnology, hygiene, geography, economic botany, regional zoology, germ diseases, agriculture, etc., etc." Prof. Rossiter, whom we should suppose to be a character compounded from the late very distinguished surgeon, Sir Victor Horsley, and from the pioneer of modern physiology in England, the late Sir Michael Foster, is given qualifications as a lecturer beyond the wide capabilities of the combined originals. Even Sir Harry Johnston himself, who has first-hand acquaintance of more branches of knowledge than almost any man living, would hesitate to carry out the programme he assigns to Prof. Rossiter.

Der Aufbau der Materie: Drei Aufsätze über moderne Atomistik und Elektronentheorie. By Max Born. Pp. v+81. (Berlin: Julius Springer, 1920.) Price 8.60 marks.

In the form of three essays the author has given a clear and simple summary of the advances which have been made during the last few years in our knowledge of atomic structure. The first essay consists of a survey of the results obtained by purely physical investigations. It describes the measurement of the charge and mass of the electron, the Kelvin-Thomson model of the atom and the Rutherford-Bohr model which succeeded it, the discovery of the diffraction of X-rays by crystals, and Moseley's work on X-ray spectra and atomic number. A short account is given of Bohr's theory and its development by Sommerfelt, of the general relationships between the spectra of the elements, and of Kossel's work on electrovalency, which determines the number of electrons in the several shells surrounding the positively charged nucleus. In the second essay, the former attempts to obtain a mechanical model of the æther are contrasted with the modern conception of all mechanical forces as being electrical in their origin. Our knowledge of crystal structures has made possible a closer examination of the inter-atomic forces in solid bodies; quantitative relationships can be obtained—for instance, in the case of sodium chloride—between purely physical constants, such as the distances between the atoms, the ionic charges, and the compressibility of the solid on one hand and the heat of formation of the compound on the other. This is amplified in the third essay. Both chemistry and physics deal ultimately with the structure of the atom, for the constants which govern chemical reactions are to be explained in terms of the forces between electrons and nucleus in the atomic structure.

In so small a volume, the author cannot do more than indicate the results which have been obtained in each line of investigation, but very complete references are given to the original papers on the subject. So much work of fundamental importance has been done in the last three or four years that this book will be welcome, both as an introduction to the most recent researches, and for the useful references which it contains.

The Elements of Electro-Technics. By A. P. Young. Pp. viii + 348. (London: Sir Isaac Pitman and Sons, Ltd., 1920.) Price 7s. 6d. net.

THIS work is addressed as much to those connected with the electrical industry who are not directly associated with the technical side as to students about to embark upon an electrical career. The subject is looked at from the practical engineering point of view, but shows some departure from conventional lines. The elementary principles of currents and their effects are well set out, and of the later chapters those on the magnetisation of iron, measuring instruments, and insulating materials may be picked out as the best examples of well-selected information arranged with originality. In the last mentioned there is a good deal not found in the ordinary text-book, including a most useful summary of the composition, preparation, and properties of a number of insulating materials in common use. Another subject not always treated satisfactorily in elementary books is that of the magneto for ignition purposes, of which there is a brief but clear sketch.

The field covered is larger than would appear at first sight, and ranges over such diverse branches of electrical applications as Röntgen rays and electric furnaces. The continuous-current dynamo and motor are dealt with comparatively briefly, but alternating currents and their applications do not form part of the scheme. The student would be well advised to turn to Mr. Young for his introduction to the subject of measuring instruments.

Modern Explosives. By S. I. Levy. (Pitman's Common Commodities and Industries.) Pp. ix + 109. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) Price 3s. net.

THIS book gives a popular and interesting account of the manufacture of explosives, with special reference to the work carried out during the Great War in the national factories in this country. Although avoiding technical details, the author has given a reasonable and well-balanced treatment of his subject in the space at his disposal. One or two slips may be noted. The oxidation of ammonia was not "discovered by the German chemist Ostwald" (p. 28), but by the English clergyman the Rev. A. Milner, although it is usually attributed to the French chemist Kuhlmann. The phrase "Haber-Ostwald process," mistakenly adopted by the Department of Explosives Supply during the war, has doubtless led the author astray. The statement that "the contact process . . . was not successful when first attempted in this country, and was first applied in Germany . . . by . . . Dr. Knecht [*sic*]" (p. 35), is inaccurate in view of Messel's work. The final chapter, on "Chemistry and National Welfare," although not directly connected with the subject, is very apposite at the present time, when many of the lessons taught by the war seem to be receding into obscurity.

An Introduction to Entomology. By Prof. J. H. Comstock. Part i. Second edition, entirely rewritten. Pp. xviii + 220. (Ithaca, N.Y.: The Comstock Publishing Co., 1920.) Price 2.50 dollars net.

WE have no hesitation in commending this book as a clear and thoroughly up-to-date elementary account of the general structure and metamorphosis of insects. It constitutes the first part of a treatise on entomology that the author has in preparation. The section devoted to the external anatomy of insects is particularly valuable.

The detailed studies of recent morphologists have left the terminology applicable to the various sclerites and regions in a very confused state; the nomenclature adopted in this book is well chosen, and should contribute towards establishing stability. With regard to the internal anatomy we are of opinion that the author should deal with the muscular system more fully in the final work. Rather more detailed reference to the adipose tissue and a mention at least of the corpora allata are also called for. These points are raised in a friendly spirit, and in response to Prof. Comstock's invitation for suggestions of any desirable changes to be made before the present part is incorporated in the complete work.

Throughout the book the author exhibits clear insight in the selection of the essentials of his subject, and the printing and illustrations are particularly good; there is also a useful and not too lengthy bibliography. A. D. IMMS.

Physiography. By Prof. Rollin D. Salisbury. Third edition, revised. (American Science Series, Advanced Course.) Pp. xv + 676 + xxvi plates. (New York: Henry Holt and Co., 1919.)

PROF. SALISBURY contrives to maintain the somewhat colourless subject of modern physiography as a study for the class-room by representing it as a description of the shaping of the present surface of the earth, and of the relations of air and water to the land. Questions of earth-history are left to geology, and of life on the globe to geography. His book might serve as an introduction to either of these sciences. Huxley's "Physiography" made a far wider appeal, and Prof. Salisbury has recently stated his own appreciation of geography as encouraging personal observation and verification.

We cannot help feeling that in the present work, the success of which is shown by its third edition, the author has been hampered by educational custom rather than by choice of subject. The small size of many of the illustrations of broad natural features is in keeping with the crispness of description. The use of parts of the maps of the U.S. Geological Survey as full-page plates is an admirable feature. The work has been brought up to date, with cautious references to the "upper air," and a description of the activity of Lassen Peak from 1914 onwards. May we suggest that the crystals shown on p. 71 should not be described as snowflakes? G. A. J. C.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Restoration of Energy.

CONCERNING the pressure of light, we may safely say that it was predicted by Maxwell, discovered by Lebedew of Moscow, and independently by Nichols and Hull in America; while it was elaborately discussed, clinched by further experiments, and its significance greatly extended by Poynting and by Poynting and Barlow. We now learn from Prof. Eddington's brilliant address to Section A of the British Association at Cardiff this year that radiation pressure has a cosmic significance beyond what had been thought possible; that it holds back or sustains the outer substance of the brighter and hotter stars, and is responsible for their huge size; while at the same time it has the effect of limiting the possible aggregation of masses of matter, so that the mass reasonably permissible to any star ranges from five times to one-half that of our sun—something of that order.

According to Prof. Eddington's calculations, the radiation from an exceedingly hot central nucleus, heated it may be by atomic disintegration, acts like a rushing mighty wind on the outer portions, and sustains them against gravitative attraction;—surely a remarkable example of the significance inevitably attaching to the most minute and barely detectable forces. So long as any given kind of force exists at all, it may under proper conditions have an overpowering and surprising effect.

I write to convey a verbal suggestion made by my assistant, Mr. Edward E. Robinson, a year or two ago, that light-pressure may afford an escape from some popular eschatological conclusions based on the doctrine of the dissipation of energy. Engineers like Prof. Osborne Reynolds and Sir William Siemens have deplored the waste of solar energy, of which so minute a fraction is caught by the earth or any planet, and have sought to circumvent and reconcentrate it somehow—by total reflection at an æthereal boundary or otherwise. And when we think of the vast store of power ceaselessly being radiated from every star, and apparently fruitlessly lost in the depths of space, it is natural to look either for some usefulness in the torrent or for some sort of compensating mechanism. So also, under the influences of gravitative attraction and the general law of dissipation of energy, it has seemed to some as if the cosmos was tending towards a cosmic tomb—consisting of one large cold or cooling lump of matter, with all the energy of its gravitative falling together wasted by radiation into the depths of space, and no recovery possible, nor any more generation of heat.

But what about the sweeping or propelling power of that apparently waste radiation? It exerts pressure on matter; particles of suitable small size must be swept along with it. Why should we not contemplate a constant sweeping of cosmic dust away towards infinity, with full power of return when sufficiently re-aggregated? Is there not some hope of restitution and restoration in this, so that gravitative fall can once more recur and the whole cycle begin again?

To estimate the amount of matter which can thus be repelled, taking into account diffraction effects, is rather complicated. It must not be enough at any one time to cause effective opacity; but, considering the speed generated by any small acceleration in free space and the length of time available, the total amount of repelled matter need not be inferior to the amount of disintegrated material which collisions and friction and eruptions and electrical repulsion are likely to provide. *Something* preserves the transparency of space; may it not be this constant sweeping away of dust? Far away from any source of radiation the particles would not be hot enough to repel each other, so there would be nothing to prevent their beginning to collect together, and so preparing to fall once more from practical infinity.

Electrified particles, ions and electrons, of which interplanetary space must contain myriads, are also propelled by light. But these seem to attain a terminal velocity, of value depending on the intensity of the radiation and the square of its wave-length. Long waves travelling in space would therefore be most effective, but short waves would act in the right direction; and the electrons thereby driven among the cosmic dust—exerting mutual forces much stronger than gravitation—might act as the cement to weld it together again.

So long as matter is being accelerated by radiation-pressure, and so long as fresh ions are being produced in its path, the energy of the radiation would tend to be consumed. Hence the ultimate result of all the otherwise waste radiation might be just that energy of gravitative separation which is required for a new Lucretian universe.

There are other possibilities, of too speculative a character, depending on the semi-material nature of light. The suggestions so far made may be negatived, but they seem worth putting forward in a tentative manner.

OLIVER LODGE.

British Laboratory and Scientific Glassware.

I HAVE no interest in the manufacture of scientific glassware, except in so far that as I devoted most of my time to the subject during the war I should like to know that my work would lead to permanent results. I may, therefore, be permitted to address a word to users and manufacturers of scientific glassware.

To users I say: Use only scientific hollow-ware which bears the maker's name; and if you find it faulty, send it straight back to the manufacturer, whom you will be assisting, and who will replace it at once. Even the famous Jena glass was often faulty, and while working in the laboratory in the autumn of 1914 it was not only once that Jena beakers were found to have cracked without apparent cause. On two occasions I actually heard beakers crack while they were standing on the table.

In the autumn of 1914 I worked out the resistance glass and lamp-working glass which have been spoken of as standing at the head of the list, and early in 1915 I began to manufacture these glasses, and continued to do so throughout the war, maintaining the original compositions, but modifying the batch formulæ as different materials became available. The glasses were worked out on the basis of analyses of a large number of foreign glasses and a study of their properties. The investigation was a perfectly straightforward one, and no particular difficulty attached to it, and I will even admit that luck came to the aid of judgment in arriving at the final conclusions.

I am making this statement because I wish it to be recognised that a misunderstanding exists as to the difficulties which had to be overcome in connection with the manufacture of scientific glassware, and not because I wish to lay claim to particular credit for carrying through a simple piece of work. The real difficulty lay in the working out of methods of manufacture, particularly the devising of mechanical methods, and in imposing them upon an industry which was rather unwilling to adopt them. The glassmaker's chair and tools had to be replaced by moulds, and even then the procedure adopted in mould-blowing as practised in the country had to be modified. Instead of employing men to finish such articles as beakers, machines had to be devised to carry out the processes which could be operated by girls. Drastic alterations in the methods of annealing had to be introduced. In some branches, such as the manufacture of graduated ware, the technical processes for production in mass had to be worked out from the commencement.

Now the fullest information as to the composition of German chemical glassware was at the disposal of anyone who had access to a chemical laboratory, such as Prof. Baker kindly placed at my disposal in October, 1914, and could make an analysis of glass. The reproduction of these glasses, on the basis of the analyses, called for some knowledge of commercial materials, and such information as was available as to the qualities of the glasses actually on the market made improvement a matter of no very great difficulty. If the chemical problems had been the essential ones the scientific public would have had every reason to complain if the manufacturers had not at the outbreak of war at once produced perfectly satisfactory scientific glassware, and had never failed to give them the most complete satisfaction. However, the actual fact is that the chemical difficulties were almost non-existent; but, on the other hand, the technical difficulties were very real, involving the expenditure of a vast amount of energy and money which had to be provided by the manufacturers themselves. I can say most definitely that all those who have been concerned in the industry have actually lost money in the venture, but that they do not grudge the cost.

During the war a vast amount of information was collected and shared between the various firms engaged in the industry, but it was often impossible to make use of it owing to the difficulties which stood in the way of obtaining machinery and plant. It would now be possible to make use of this information, to reorganise completely factories for mass production, and to install new plant, but the manufacturer is hampered by the stringency of the financial position, the enormous increase in the cost of machinery, etc., and the absolute uncertainty as to the policy of the Government. However, if the industry is doing its best to meet the situation, it deserves the support of the scientific public, which has also the right to demand guarantees. I suggest, therefore, that the manufacturers should invite the Institute of Chemistry and the Institute of Physics, which represent the professions most closely concerned, to investigate the position of the industry and to report upon it.

It must not be imagined that the cost of scientific glassware will ever approach the pre-war standard, and it does not appear that the increase in cost is in excess of the increase in cost of other commodities. During the war, while I had the opportunity of checking the figures, I know that our prices were lower than the pre-war prices relatively to the increase in the cost of production. Temporarily, owing to the rate of exchange, German glass is obtainable at a lower rate than English, but if this fact is taken advantage of now, the scientific public is likely to have to pay for its short-sighted policy so soon as the industry is once more completely in German hands.

M. W. TRAVERS.

November 6.

Negative Electron Curve.

THE elements are constructed, so it is now believed, of collections of hydrogen atoms bound together by negative electrons. The atomic weight of an element is not, as a rule, a whole number. I think the importance of this departure from integers is most significant.

If we can consider that the element is composed of a number of hydrogen atoms, then the departure from the simple sum of the weight of the hydrogen atoms composing the element must be due to the negative electrons. For example, the element vanadium has an atomic weight of 51·06. Suppose we consider it to be composed of 51 hydrogen atoms,

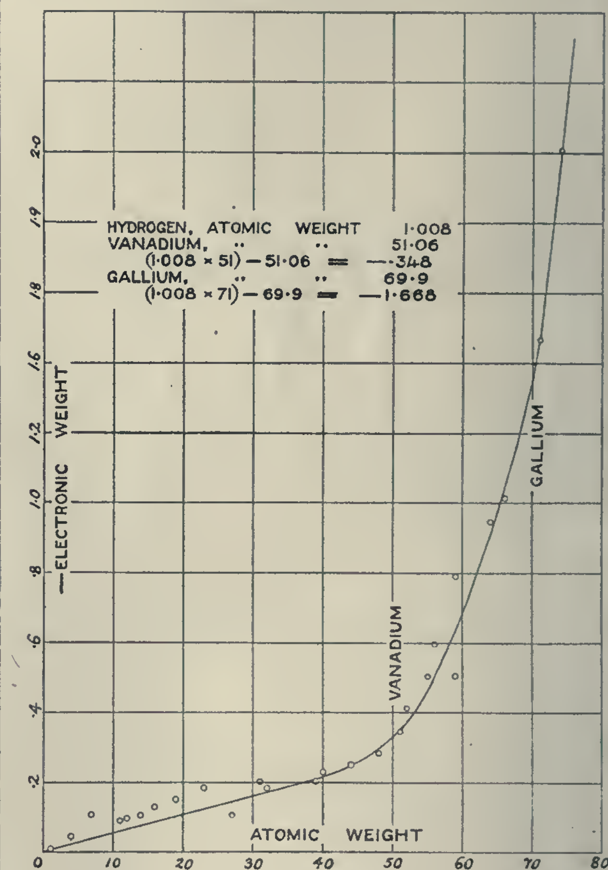


FIG. 1.

then its atomic weight should be $1·008 \times 51 = 51·408$; but its atomic weight is 51·06. The difference is $-0·348$, due, I take it, to the negative electrons which have entered into the composition of the element.

I have obtained *minus* quantities for a number of the elements, starting from hydrogen, atomic weight 1·008, and stopping at Ge, and I find that they space themselves along a regular curve, as shown in Fig. 1. That the *minus* quantities of the atomic weights should have arranged themselves in this regular way by pure accident I cannot believe, so I suggest that there is some natural law at work to account for it. The explanation is to be sought, I think, in the supposition that the hydrogen atoms attract each other, producing the force of gravity, while the negative electrons are repulsed by gravity; the elements are, therefore, lighter than the sum of the hydrogen atoms themselves.

Referring again to the curve, if the helium atom is composed of 4 hydrogen atoms and 2 negative electrons, then vanadium should have 51 hydrogen atoms and somewhere about 34 negative electrons.

The elements beryllium, neon, magnesium, silicon, chlorine, and argon do not seem to come properly in the curve. If their atomic weights have been correctly determined, then there must be something peculiar about these elements.

I have also drawn a curve from the atomic weights as given in Bloxam's "Chemistry," hydrogen being taken as 1, and have produced a similar curve to the one given here, except that the latter part does not rise so steeply.

S. G. BROWN.

52 Kensington Park Road, W.11.

Chemical Warfare and Scientific Workers.

LIKE Prof. Soddy (NATURE, November 4, p. 310), I have received an invitation from the War Office to become an associate member of the "peace" organisation which is to "develop to the utmost extent the offensive and defensive aspects of chemical warfare." I have had enough practical experience of the experimental side of chemical warfare to know what it involves, and I have without any hesitation refused to join the new Committee.

In the first place, the project is simply wicked. Education stands for something more than the acquisition of knowledge, and if at the present time I lent any support to the activities of the Committee I feel that I should necessarily be quite unfit to take any part in the training of young minds. To do what I can to promote in everyone the faith that war is done with has become part of my business because it is the world's business. In the second place, the project is futile. No real progress will be made in discovering new methods of offensive chemical warfare except by people who have their heart in it; perfunctory adhesion to an official organisation will discover nothing worth knowing.

Is any intelligent person—and only intelligent people would be of any use in this very complicated subject—at this point in the world's progress going really to put his heart into the search for methods of killing other people? I think not, even in the case of professional soldiers. Some may comfort themselves with the idea that they will escape the moral difficulty by engaging only with defensive methods. This will be equally futile, for adequate defence can only follow discoveries on the offensive side; it cannot precede them. It is impossible to devise protection against offensive agents which are unknown, just as on the medical side it is impossible to work out methods for the cure of lesions of an unknown nature. The only effective preventions and cures which can be prevised are ethical, and a War Office Committee is not quite the best atmosphere for that.

It may be extravagant to expect that all civilians will refuse to support this part of our "peace organisation," but I hope they will.

A. E. BOYCOTT.

University College, Gower Street, W.C.1,
October 5.

Testing Einstein's Shift of Spectral Lines.

A WORD of caution may not be amiss in respect of the suggestion made by Sir Oliver Lodge in NATURE of October 28, p. 280. The rotational stresses in the disc, though very large, may not portend immediate dissolution in steel, but what of the glass (?) of the vacuum tubes? The stresses, like the gravitational effect, increase as the square of the angular velocity. The method would seem well calculated to develop pleochroic effects in glass.

CHARLES CHREE.

October 30.

Contractile Vacuoles.

CONTRACTILE vacuoles are found only in those cells which lack a continuous cell-wall. This appeared to suggest that the function of the contractile vacuole is to eliminate dissolved crystalloids and so to keep down the osmotic pressure distending the semi-permeable protoplasm. Otherwise the latter, lacking the support which a continuous cell-wall gives, would continue to stretch and would finally rupture.

There is, however, another, and possibly more plausible, point of view, namely, that the contractile vacuole is, in point of fact, this rupture. Suppose a small accumulation of a soluble crystalloid in a semi-permeable gel which exhibits slight elasticity and slight tenacity—qualities which the protoplasm of the cell appears to possess. The osmotic pressure of the crystalloid will push back the protoplasm, overcoming its rigidity. Thus a cavity is formed which enlarges as water flows into it. Expansion will proceed until but a very thin film of protoplasm separates the solution from the surrounding water. Later expansion causes continued thinning of the film until its tenacity suddenly gives way, and the solution contained in the vacuole becomes, through the rupture, continuous with the surrounding water. The elasticity of the protoplasm now asserts itself, and the walls of the cavity are driven together. The semi-fluid, viscid constituents of the protoplasm secure the healing up of the rupture and the obliteration of the cavity, while the viscosity of the surrounding substance leads to a delay in recovery marked by the appearance of the radiating canals.

Thus we may look upon a contractile vacuole, not as an organ of a cell, but rather as the effect of the local accumulation of any soluble substance. In fresh-water naked protoplasmic organisms the formation of a cavity surrounding this accumulation and the periodic forcible ejection of some of the solution are rendered inevitable by the physical properties of protoplasm. When once a cell acquires a complete cell-wall, the protoplasmic film receives sufficient support and the vacuoles become permanent.

HENRY H. DIXON.

School of Botany, Trinity College, Dublin,
October 22.

Visibility of the Landscape during Rain.

ON a recent visit to the mountains of North Wales the writer was impressed with the variations in the visibility of the landscape when rain was falling. In the lower valleys a storm which may be sufficient to wet thick clothing through in a few moments may leave the contours of the mountains quite distinct at several miles distance. On the other hand, a mountain drizzle or "Scotch mist" may render everything invisible at a few yards. An elementary treatment of the subject brings out one or two points of interest.

Let it be assumed that the raindrops are perfectly opaque and that the atmosphere is otherwise perfectly transparent, both assumptions being, in general, close approximations to the actual state of affairs.

Consider a heavy rainstorm during which rain falls at the rate of 1 cm. per hour, or 0·00028 cm. per second. The raindrops appear to be most often of 1 to 2 mm. diameter. Taking the lower value (1 mm.), the volume of the drop is $0{\cdot}5\times10^{-3}$ c.c.

According to Stokes's law

$$v=\frac{2r^2(\rho-\rho_1)g}{9\eta},$$

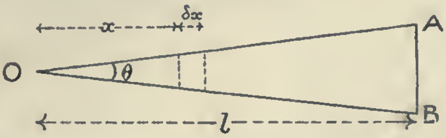
and at 15° C., η, the viscosity of air, is 181×10^{-6}, so that $v=3000$ cm. per sec.

Consequently, the depth of water which falls in one second (0·00028 cm.) is spread while falling over a vertical column of air 3000 cm. high.

There is, therefore, 1 c.c. of water in about 10^7 c.c. of air, or 1 raindrop in every 5 litres or so . . . . (1)

Now, in the state of maximum disorder (the "most probable" state) the raindrops will be spaced equally in all directions, vertically as well as horizontally, and the average distance between two spots will be

$$\sqrt[3]{5000}=17 \text{ cm.} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$



Consider a circle of landscape, of diameter AB, subtending an angle θ at the observer at O, distant l from AB. AB $=l.\theta$.

A spot of rain at x is projected against the background as a disc of diameter

$$\frac{l\,.\,d}{x}$$

(d being the diameter of the spot) and blots out an area

$$\frac{\pi}{4}\left(\frac{ld}{x}\right)^2.$$

If n denotes the number of rain spots in unit volume of air, then in the element ∂x of the cone in the figure there are

$$n\,.\,\frac{\pi}{4}(x\,.\,\theta)^2\partial x,$$

and these, projected on the background, blot out an area

$$n\left(\frac{\pi}{4}\frac{x\,.\,\theta\,.\,ld}{x}\right)^2\partial x,$$

or

$$n\frac{\pi}{4}\,.\,d^2\delta x\times\frac{\pi}{4}(l\,.\,\theta)^2,$$

or

$$n\frac{\pi}{4}\,.\,d^2\,.\,\partial x\times\text{Area of background} \quad . \quad (3)$$

Hence each element ∂x contributes the same amount of blotting-out of the landscape, the larger apparent diameter of the nearer spots being compensated by their smaller numbers, and the visibility of the landscape falls off as a linear function of the distance.

The total area blotted out is the integral of (3), *i.e.*

$$\frac{\text{Area of projected rain spots}}{\text{Area of landscape}}=nl\left(\frac{\pi}{4}d^2\right),$$

and the landscape is entirely blotted out when the above ratio equals unity.

Putting

$$n=\frac{\text{Depth of rain falling per sec. (D)}}{\frac{\pi}{6}\,.\,d^3\,.\,v}$$

in this equation, we get as the limiting distance at which the outlines of the landscape can be distinguished

$$l=\frac{2}{3}\frac{d\,.\,v}{\text{D}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Using the values suggested above, $d=0·1$, $v=3000$, and $\text{D}=28\times10^{-5}$, the value of l comes out as 7 km., or $4\frac{1}{2}$ miles.

Thus a very heavy rainstorm may be remarkably transparent.

Let N = the number of spots falling per second on unit area (N $=n.v$), then, combining equation (4) with Stokes's law, and calling $\frac{1}{l}$ the obscuring power of the storm, we have

$$\frac{1}{l}=\frac{9\pi}{4g}\,.\,\eta\,.\,\text{N} \quad (\text{since } \rho-\rho_1=1) \quad . \quad . \quad (5)$$

That is, the obscuring power of a storm is simply proportional to the number of spots falling per second, or every raindrop has the same obscuring power, whether it be large or small and whether the total rainfall be heavy or light.

The very great obscuring power of a "Scotch mist" is thereby accounted for.

F. W. PRESTON.

90 Howard Road, Leicester, October 21.

Museums in Education.

IN NATURE of October 28 appeared a review of the Final Report of the Committee (British Association, Section L) on "Museums in Relation to Education," in which it was stated that "our great public schools have some excellent museums, but there is little or no evidence that they are used in school teaching." May I be allowed to point out that this sweeping indictment of incapacity or lack of imagination on the part of masters in public schools is not without exception?

The museum of natural history at Oundle School is, I suppose, fairly typical of such collections. It consists of specimens representative of zoology, botany, palæontology, and petrology. Owing to lack of space, not all the specimens can be exhibited with advantage, and the excess has been temporarily stored, so as to avoid detracting from the educational value of the exhibits, pending the erection of a more spacious building. The present museum, which is apart from the laboratories, is accessible at all times to all boys whether or not they are taking natural history subjects in the curriculum. The zoological collection forms an index to the animal kingdom; it consists of specimens representative of all the phyla and of a considerable number of classes. These are distinctly grouped and clearly labelled. In further amplification of this series a certain number of drawings, dissections, and skeletons, also clearly labelled, are interspersed among the types. This work has been carried out entirely by the boys, under supervision, and forms, therefore, an elementary introduction to research. There are also table-cases representative of protective coloration, insect pests, metamorphosis, etc. Owing to lack of time and space the botanical exhibition is not so far advanced, but there is a good collection of types of timber on view, while a collection representative of the dispersal of fruits and seeds is in the making. During the summer term the younger boys maintain a constant display of the flowering plants of the neighbourhood. (The lack of botanical exhibits in the museum is largely compensated for by a botanical garden comprising natural-order beds, a rock garden, a rose garden, marsh and aquatic flora, etc.) The palæontological collection consists of a series of wall-cases containing fossils arranged according to their strata. The petrological collection comprises table-cases illustrative of the more common rock-forming minerals, with a considerable number of good specimens clearly arranged and classified. For the two latter collections, as regards both material and arrangement, the school is indebted to the great kindness of Profs. Marr and Solly respectively.

More than three hundred boys (out of five hundred) are undergoing biological training at Oundle School in any one term. In teaching biology I have constant recourse to the school museum. For example, a class may be taken into the museum and a demonstration given of the general characters of the animal kingdom; or certain exhibits illustrative of one particular subject can be removed from the cases to the laboratory, where, after a short description, they can be sketched by the class. A similar use of the museum for practical education is made by my geological colleague. Further use of the collections has been made for popular demonstrations to members of a local society as well as to parents of boys who visit the school on Speech Day; on these occasions the boys themselves act as demonstrators. Such, in brief, are some of the uses to which a school museum is put in the service of education.

That the knowledge of such efforts in education has not come to the powers-that-be only emphasises the deplorable fact of the present lack of co-operation between the school and the university. As assistant in the zoological departments of Manchester and St. Andrews Universities I learnt the immense value of the museum as an aid to biological education. My experience of school work is confined to the brief period since the close of the war, but I cannot believe that no effort is being made similarly to use the museums of natural history in other schools where a biologist has been added to the staff of masters.

E. W. SHANN.

Oundle School, Northamptonshire,
October 31.

Mating Dances of Spiders.

I HAVE not, up to the present, found any account of anything approaching to a mating dance, such as is common among the Salticides, in the Lycosides. The following observations tend to show, I think, that some such dance must exist among certain members of this family. I should be glad to know if any readers of NATURE have met with similar experiences with these spiders.

The species observed was *Lycosa saccata* (Blackwall), which is exceedingly common in the spring. I was watching a number of these spiders at about 3 p.m. on April 29, 1919. They were sunning themselves on a vertical wooden board leaning against a cucumber frame. I first noticed a male, which was about 1 in. from a female, going through some most curious movements. He extended one palp downwards (at about 45°) and the other upwards, at the same sort of angle. He then withdrew them and extended them again in the same way, but with their positions reversed. Each time he withdrew them he usually took a step towards the female. He repeated this two or three times, and then brought the palps to their normal position with a curious quivering movement. The front legs were also caused to quiver, being held just off the ground. The front legs of the female were occasionally seen to quiver also.

When the male got up quite close to her (½–¼ in.) the female ran off, and the male searched about within 2 ft. of where he lost her, exploring crevices, etc., as though looking for her. At last he suddenly encountered her round a corner, and she ran away. He proceeded with his antics, however, without her being there.

A new male then appeared and began similar antics in front of the female, except that he merely extended each palp separately and returned them to their former position. The original male then came up and a fight ensued, in which both spiders fell off the board, leaving the female to continue her basking in the sun.

G. H. LOCKET.

Lincoln College, Oxford, November 1.

The Energy of Cyclones.

IN NATURE of October 28, p. 286, Lt.-Col. Gold refers to the theory of the late Dr. Margules, that storms would arise if two masses of air of different temperatures were in juxtaposition. The situation would be unstable, and in passing from this unstable situation to a stable one the potential energy would be reduced, part of it being converted into the kinetic energy of the ensuing "storm." The theory takes it for granted that the warm air rises and the cold air descends.

But storms are generally associated with cyclonic depressions, and of recent years the temperature distribution in cyclones has been carefully studied. Sir Napier Shaw (Meteorological Office Geophysical Memoir, No. 210*b*, p. 14) sums up the facts as follows: "The conclusions which we may draw are, first, that the pressure changes at the surface are a reproduction of the pressure changes at the 9-km. level, and that they must be regarded as produced, not by, but in spite of, differences of temperature in the air."

The theory of Dr. Margules, consequently, fails entirely to account for cyclones. On the other hand, his theory may play some part in the production of line squalls and some thunderstorms.

With regard to "polar fronts," the theory of Dr. Margules is also at fault in a great measure. The low-pressure areas over the polar regions produce the two great polar cyclones. The atmospheric columns over the poles must be relatively warmer than those over middle latitudes. As a result, the warm air is drawn polewards. But, although the atmospheric columns over the polar areas are relatively light, there are cold, dense layers of air resting on the earth's surface. These cold polar layers are pressing outwards, and where they meet the warm cyclonic inflows we have the "polar fronts."

The facts seem to point to the stratosphere as being the main source of energy of storms and trade winds.

R. M. DEELEY.

Tintagil, Kew Gardens Road, Kew, Surrey,
October 30.

DR. MARGULES wrote his paper mainly in connection with phenomena of the line-squall type, but he realised that it might have wider applications, and later investigations do indicate that discontinuity of temperature is the prime factor in the "birth" of cyclones. If one had an atmosphere with uniform pressure at sea-level, but with masses of warm and cold air, then at 9 km. pressure would necessarily be low in the mass of cold air, and a cyclonic circulation would ensue; but the energy of the motion would be derived from the potential energy of the initial state.

Differences of temperature originate in the lower atmosphere. The stratosphere may be able to draw upon a source of energy of which we are ignorant; it cannot of itself provide the energy of storms.

E. GOLD.

Luminosity by Attrition.

IN reference to the letter in NATURE of November 4, p. 310, by Sir E. Ray Lankester on the above phenomenon, it may be of interest to some to know that Thomas Wedgwood was the first to direct attention to the fact that light could be produced by the rubbing together of quartz or sugar. His paper on "Experiments and Observations on the Production of Light from Different Bodies by Heat and Attrition" may be found in Phil. Trans. Roy. Soc., 1792, part i.

C. CARUS-WILSON.

November 6.

Industrial Research Associations.

I.—British Scientific Instrument Research Association.

By J. W. Williamson.

THE British Scientific Instrument Research Association is one of the earliest research associations formed under the scheme of the Committee of Privy Council for the promotion of scientific and industrial research. It was founded, as is stated in the third annual report of that Committee, "through the efforts of the optical industry, guided by the whole-hearted energy and zeal of Mr. Conrad Beck, the president of the British Optical Instrument Manufacturers' Association." The association was incorporated on May 30, 1918, and established on lines broad enough to include all scientific instrument makers. In November, 1918, a group of firms representative of the electrical scientific instrument, electro-medical, and X-ray industries joined the association, which may now claim to be what the above-named report of the Committee of Privy Council stated in August, 1918, it had every prospect of becoming—the representative industrial body dealing with the application of science to the manufacture of scientific instruments. The association was fortunate in securing from the outset as its director of research Sir Herbert Jackson, K.B.E., formerly Daniell professor of chemistry at King's College. Mr. J. W. Williamson was appointed secretary of the association, and, later, Mr. H. Moore assistant director of research, with special reference to the electrical and X-ray researches of the association.

The first task of the newly formed association was to secure suitable premises for offices and research laboratories, and in November, 1918, the remaining term of the lease of 26 Russell Square, W.C.1, was purchased, and the association entered into possession on Armistice Day, November 11, 1918. Steps were immediately taken to effect the necessary structural alterations and to equip the premises with laboratories and secretarial offices, and now, on the completion of its first two years of life, though more remains to be done, the association has a relatively well-equipped research institute, with a scientific staff of six research workers, all university graduates experienced in research, in addition to the director of research and the assistant director of research.

In the beginning the association suffered a grievous loss by the untimely death, in August, 1918, of its first chairman, Mr. A. S. Esslemont, on whose wisdom, zeal, and powers of organisation the members had confidently counted to guide the association in its early career. He was succeeded in the chairmanship by Sir Arthur Colefax, K.B.E., who rendered valuable service to the association, and when, owing to the pressure of other duties, he was compelled to resign the chair some months ago the association was fortunate in securing as chairman Mr. A. A. Campbell Swinton, whose high scientific attainments and wide experience will be of great benefit to the association.

The council of the association consists of fifteen elected members, five co-opted members, and five members appointed by the Department of Scientific and Industrial Research. The addition to the elected members of council of these Department representatives and co-opted members has been of great service to the association in enabling the council to view from a wide angle and to a far horizon the varied problems presented to it, without impairing the predominant interest of the members representing the industry or modifying the necessary bias of the association's activities towards practical results.

The main and immediate functions of the association, the council has agreed, are :—

(*a*) To prosecute research into the questions of pure and applied science arising out of the urgent needs of the scientific instrument industry.

(*b*) To take long views and to investigate those questions, whether of pure or applied science, upon which the future of the industry may be conceived largely to depend.

(*c*) To investigate systematically and continuously the field of application of scientific instruments.

Time and experience will show whether and how far these guiding principles need to be modified or amplified.

Just as the actor's art, however subtle, will fail if it does not get over the footlights, so will these associations for scientific and industrial research fail in one of their primary functions if they do not get the results of their researches over into the workshops of the industries. Two years is all too short a time for any association to accomplish much in this way. The first year is necessarily spent mainly in organisation and preliminary surveys of work under contemplation. But the British Scientific Instrument Research Association has, nevertheless, obtained results of research of immediate utility which have already found practical application in the workshops, and are of considerable benefit to the industry.

For example, as the result of an extensive research on polishing powders, a rouge was prepared for the hand and machine polishing of lenses, prisms, etc., which, tested by optical firms, has proved to be thoroughly successful in the workshop. It has been manufactured on an industrial scale, and is now standardised and in regular use by optical firms. This research has given rise to much investigation on the purely scientific side, and to further work of an applied nature with the view of decreasing substantially the time of polishing glass and similar materials. The comprehensive researches of Sir George Beilby on this subject, especially in connection with the flow of solids under mechanical disturbance, has been of great value.

Another line of investigation which has been occupying the association from the start is on abrasives. Much work has already been done both from the purely scientific point of view and on the production of abrasive powders. Materials made in the laboratory are being tested in workshops, and it is hoped soon to publish reports on the whole investigation and on the practical results.

Again, in response to a need expressed by the industry a solder was prepared in the association's laboratories capable of being used for all the ordinary metals, including aluminium, and of withstanding a temperature of approximately 350° C., so that it could be used when the later heating of joints made by it was necessary—*e.g.* in enamelling. This also has been manufactured on a large scale, and industrial firms are engaged on extended tests of it. The reports to hand are very promising. Another solder, fusing at a low temperature, for special use with aluminium, has also been made on the laboratory scale, as the outcome of the previous research, and is now being tested by certain firms.

The association has also been able to give immediate assistance in the matter of securing suitable and trustworthy liquids for level bubbles, and is now engaged on problems connected with standardising the glass for the bubbles and with methods of preparing the inside surface. In this connection it has been considered important that purely scientific research on the fundamental physical problems connected with this investigation should be prosecuted so that not only may the practice in manufacturing level bubbles be improved, but also the reasons underlying it may be fully elucidated. This is being done for the association, extramurally, in one of the London technical colleges.

An interesting investigation, apparently dealing only with a small detail brought to the attention of the association, led to a considerable amount of research work on the cause of the tarnishing which had been found with certain tissue papers used for wrapping up polished glass. A report on the whole research has been issued to members, and so far as the practical issue is concerned the position is apparently quite clear as to the properties which the paper must have and the method of testing whether it has them. Here, again, the research has given rise to problems which are of great interest in connection with physical and chemical questions about colloids, and would be suitable for further investigation on academic lines. It is under consideration what arrangements can be made for this work to be done elsewhere in some university or technical college.

Another research of immediate practical importance to the optical industry is the research on cements for prisms and lenses. A report on this subject has been issued to members, and in the important matter of obtaining cements which have no tendency to change either in the direction of crystallisation or in the gradual deposition of insoluble matter, and do not tend to break away from the glass surface, very considerable progress has been made. This investigation on cements has led to a large amount of relevant work in the matter of insulators, a subject of importance to the electrical members of the association, and is an example of the advantage of the wider outlook which is obtained in an association such as this where the needs of one of its departments are co-ordinated with those of another. There are, of course, many scientific problems raised here which might well prompt pure science research—*e.g.* into the causes and conditions of crystallisation or of other instability in resinous and similar substances.

Questions on the purity of chemical compounds and on the relation of purity to stability are raised by the research being undertaken by the association to study the durability of different types and meltings of optical glass under a variety of conditions. Similarly, another research of the association into the question of the production of a glass of truly neutral tint raises fundamental questions of the theory of colour in glass.

It is impossible in a short article to do more than take almost at random a few examples of the researches being undertaken by the association, but enough has been said, perhaps, to show that, even in those researches being prosecuted for immediate practical ends, fresh problems in pure science are raised, or wider vistas opened out, which may well be suggestive and stimulating to the workers in the laboratories of purely scientific institutions.

The programme of research of the association is, naturally, rather the private affair of the association, but it may be said that it ranges from problems in pure science involving the fundamentals of optical, electrical, or chemical theory to technological investigations on the methods and materials of manufacture, including, for example, such a practical problem as the best lacquer for making an instrument look well finished.

It may be well to point out that, besides the specific researches included in the programme of research, the association in its character as the scientific centre of the industry is called upon from time to time to assist the industry by contributing from a scientific point of view suggestions and criticisms to the appropriate Government and other quarters on such matters as the supplies of raw materials and the manufacture in this country of products essential to the development of the British scientific instrument industry. Much work in this direction has already been done. Moreover, users of scientific instruments have already brought to the notice of the association, and, as the association becomes better known, will doubtless tend increasingly to bring to its notice, their specific needs. In this way the association will perform a useful scientific *liaison* office between the users and the manufacturers. Already, by means of conferences and otherwise, the association has enabled the manufacturing members to become better acquainted with the scientific needs of the users, and the users to appreciate the limitations imposed on the manufacturers by design, material, or other conditions.

In the task of industrial reconstruction after a devastating war which the British scientific instrument industry, in common with other British industries, has now to face and accomplish, its most potent means must be the extension of scientific research to the varied problems of the industry. In this work the co-operative research of the association and the particular research of the individual firms are essential and complementary. The work of the association does not supersede, but emphasises the need for, and assists, the scientific research undertaken by individual firms. In the same way, the pure science research of the universities and kindred institutions is essential and complementary to all research carried out by the research associations or by industrial firms. The universities and their like are the great sources of purely scientific research, and to them we look for that fundamental work which, probably in many cases not of immediate applicability to industry, is bound to be the foundation of future guiding principles. Nowhere is this more fully recognised than in the British Scientific Instrument Research Association. Its work is also largely purely scientific, but to fulfil its purpose of immediate utility to its relevant industries it necessarily cannot always follow through to completion the numerous lines of investigation which arise out of the problems studied.

Microseisms.

By J. J. SHAW.

HOW often we use the term "terra firma"! It is used despite the fact that no square yard of the earth's surface is ever at rest; an unending train of waves, waxing and waning in amplitude, are unceasingly coursing along the earth's crust and to unknown depths. The wave period ranges between 4 and 8 secs.; the amplitude is between 1/50,000 and 1/2000 in., but with a wave-length of 8 to 16 miles. The speed of the waves is believed to be about 2 miles per sec. These microseisms have been known to seismologists for twenty years or more, and were originally thought to be air tremors. Later, the rocking of the observatory buildings in the wind was suggested as their origin, or the rocking of the ground due to the motion of trees in the vicinity; but it is now established that these disturbances are pure earth-movements travelling over long distances. With sensitive seismographs, microseisms are easily recorded, but whilst hypotheses have not been lacking, their origin and cause still remain unknown.

Prof. John Milne, in 1898, suggested ("Seismology," p. 285) that the cause may be twofold: (1) air currents and convection currents within the instrument cases; (2) a ground movement produced by rapid changes of barometric load. Before that time, Bertelli and Rossi had noted the connection of microseisms with barometric change.

In America, Burbank observed an increase in amplitude when a barometric load passed from land to sea, or *vice versa*. At the International Seismological Congress held in Manchester in 1911 funds were provided for the investigation of microseisms, and Prof. O. Hecker, of Strasbourg, was deputed to undertake the work.

Daily comparisons were made between the microseisms recorded and the state of the sea at Cape Grisnez, Heligoland, and Borkum, a connection between sea waves and these movements having long been suggested. The war intervened, and the conclusions do not appear to have been published.

In earthquake investigation observers are by this time fairly familiar with the easily recognisable chief phases, viz. "primary" and "secondary" waves, followed by "long waves" which rise to a "maximum"; hence it is comparatively simple to trace any particular phase around the globe, and by this means to determine the respective rates of propagation and to compile seismological tables for future guidance.

Microseisms do not lend themselves so readily to this kind of treatment. Fig. 1 illustrates a section of a record when microseisms are pronounced, and shows how similar one train of waves is to the next, thus defying identification of any particular wave at distant stations.

In May, 1917, the present writer was testing two similar seismographs in different buildings 60 ft. apart. The machines were arranged on the same electrical time circuit, and both oriented in the same azimuth. It was observed how closely similar were the microseisms on both records, showing that the air tremor hypothesis was untenable. A seismograph has two kinds of sensitivity—one to tilt, in which the period of the pendulum plays the more important part; the other to a horizontal thrust, where the ratio of the leverage, operating about the "steady-point," is the chief factor. These seismographs were constructed with the same sensitivity to horizontal thrusts, but, as an experiment, the period of one pendulum was raised until the sensitivity to tilt was four times that of the other. Under these conditions the recorded amplitude of the microseisms was approximately the same, whereas the large waves of an earthquake which were recorded were from three to seven times greater on the machine more sensitive to tilt. This seems to suggest that microseisms are principally a horizontal motion; but against this must be noted that seismographs designed for vertical motion record microseisms quite freely.

The fact that microseisms could be identified on instruments 60 ft. apart pointed to the advisability of attacking these waves on entirely new lines, viz. gradually to extend the distance between the observing stations so long as the identification of the individual waves remained possible. The use of a "dug-out" in a pit bank was secured, distant two miles from the home station, in a direction 17° west of north, and one of the instruments installed there. Both instruments were arranged in the same azimuth, with the same period, damping, and ratio of magnification. The clocks could be synchronised only by motoring between the two stations with a watch that varied about one-fifth of a second per hour. Comparisons were made

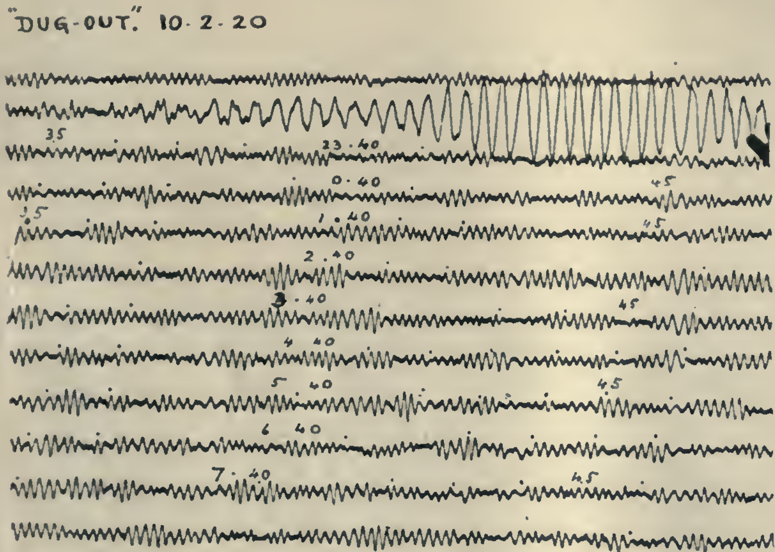


FIG. 1.—Earthquake and microseisms.

both ways, and the precision was calculated by interpolation. On favourable occasions the clocks were set alike within about one-tenth of a second.

It was at once seen that there would be no difficulty in identifying the waves at stations two miles apart (see Fig. 2). The films were timed by a short

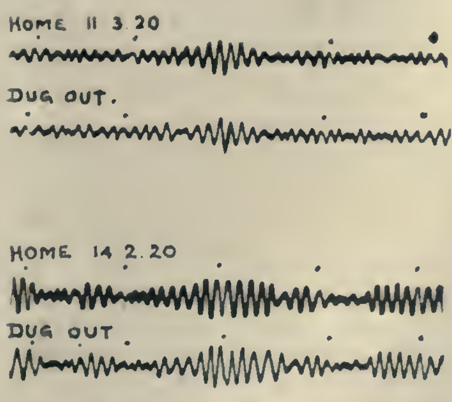


FIG. 2.—Comparative traces.

eclipse of the light every minute. In the first attempt the clocks were compared once daily, and the films timed by measuring from an eclipse to the nearest apex in the trace. By this method differences of as much as two seconds were noted, whereas one second was the maximum expected from the known rate of surface wave transmission. It was evident that a higher precision was necessary. The errors were chiefly traced to a lack of uniformity in the peripheral speeds of the recording drums. In a second series of observations the clocks were compared twice a day, and comparisons of the films limited to the point marked by the eclipse. For the success of this device it was necessary to obtain a record of the wave during the eclipse. This was achieved by cutting a fine slit across the shutter, so that whilst the beginning or end of the eclipse was still clearly defined, the leakage of light through the slit produced a "ghost" during the eclipse.

With the beginning and end of an excursion, and also the time-mark being defined, it remained only to resolve the harmonic motion to obtain the phase of the wave at each station at the instant the shutters closed, and so to deduce the time difference between the two observatories. By the first method there were readings ±1·13 sec. from the mean. By the second, this was reduced to ±0·3 sec.; but it is worthy of note that by either method the difference between the two means was only 0·04 sec. for the series.

It was noted that the wave period increased with the amplitude, and the amplitude increases generally with the daily movement of the air. There was, however, one marked exception on March 10, when a very moderate air movement coincided with nearly the maximum amplitude recorded. At this time rough weather was being experienced around the north of Scotland.

The chief objective in these proceedings was a comparison of wave direction with wind direction, and perhaps in its complete failure lies the greatest value of these observations, for it was discovered, it is believed for the first time, that there is practically no change in the wave direction, whatever the meteorological conditions may be. The microseisms always came, more or less, from the north—they always arrived at the "dug-out" first by about 0·8 sec. The small variations in time difference shown in column 2 of the table may or may not indicate a varying azimuth. It is equally probable that they are the result of personal or instrumental error.

To reduce the difficulties and shortcomings in the above experiments, it is proposed—with improved timing facilities and three machines placed at the corners of a 10-mile triangle—to continue this investigation, when it is hoped not only to obtain more precisely the rate of propagation, but also to determine to what extent the azimuth is constant. It would be of value if observers in other countries were to pursue the study of microseisms on this new system in order to determine whether this unidirectional character of the phenomenon is universal, and, if so, whether the direction is governed by the contour or physical features of the country.

By First Method.

Date, 1920	Difference, Sec.	Wind direction	Daily horl. motion of the wind, Miles	Amplitude μ	Wave period, Sec.
Jan. 31	0·0	S.—W.S.W.	427	5·8	7·3
Feb. 2	0·0	S.W.—S.	587	4·0	7·5
,, 6	1·5	S.S.E.	295	2·8	6·7
,, 9	1·0	W.S.W.	491	3·2	6·3
,, 10	1·0	S.W.	670	9·5	8·0
,, 12	0·0	W.N.W.—S.	354	3·6	6·2
,, 13	2·0	S.S.W.—W.	528	6·4	6·8
,, 15	1·5	S.	423	5·0	6·2
Average	0·87		472	5·0	6·9

By Second Method.

Date, 1920	Difference, Sec.	Wind direction	Daily horl. motion of the wind, Miles	Amplitude μ	Wave period, Sec.
March 4	1·0	W.S.W.—S.	260	4·9	7·5
,, 5	1·0	S.	285	1·6	6·7
,, 6	0·75	S.	476	4·5	6·0
,, 8	1·1	N.W.	407	2·4	6·7
,, 9	—	W.	178	—	—
,, 10	0·7	S.S.W.	272	7·0	7·0
,, 11	1·1	N.W.	257	4·9	6·5
,, 12	0·5	W.	541	5·7	6·0
,, 13	1·0	S.	377	4·5	6·2
,, 18	0·8	W.	500	4·0	6·7
,, 19	—	W.	228	2·0	6·0
,, 20	—	W.	131	0·8	5·5
,, 24	0·8	S.	348	4·0	7·3
,, 26	0.7	S.	613	5·3	7·3
,, 28	0·8	S.	498	3·2	5·7
Average	0·83		371	3·9	6·5

The Tercentenary of Jean Picard.

By Dr. J. L. E. Dreyer.

AN article on "Le tricentenaire de l'abbé Picard," by M. E. Doublet, in the *Revue générale des Sciences* (September 15–30), directs attention to the tercentenary of the well-known French astronomer, Jean Picard, who was born on July 21, 1620. Very little is known about Picard's life, so that even the year of his death is uncertain (about 1683). He was a pupil of Gassendi, and took up the study of astronomy at latest in 1645, when he observed the eclipse of the sun on August 21 of that year, and it was as an observer that he was chiefly distinguished. Though he was not the first to apply telescopic sights to astronomical instruments, he was almost certainly not aware that this had many years before been done by William Gascoigne; but Picard was at any rate the first to make use of this invention in an extensive series of observations, when he, in 1669 and 1670, determined the size of the earth. This was done by a triangulation from Sourdon, near Amiens, to Malvoisine, south of Paris, on the plan first proposed and carried out by Snellius about fifty years earlier. Picard measured a base along a level and well-built road from Villejuive to Juvissy, 5663 toises long. It is deserving of special notice that he compared his standard toise with the length of the seconds pendulum, "lest the same should happen to it as had happened to all previous standards"; and that did indeed happen, for his toise is lost. The results of this, the first modern geodetic operation, were published in Picard's "Mesure de la terre" in 1671.

In 1669 Picard presented to the Academy a memoir on the most important astronomical observations which ought to be undertaken. Among these is a new determination of the right ascensions of stars by direct comparison with the sun; this had never been done before without observing an intermediary body (the moon or Venus) which could be seen in the daytime. But it was now possible, as Picard had found in the previous year, to observe stars in daylight with the telescope attached to his quadrant. Another desirable undertaking was the accurate determination of the position of Tycho Brahe's observatory. This he was able to carry out in 1671, when the Academy sent him to Denmark for that purpose. The results of his observations on the site of Uraniborg were published in 1680 in his "Voyage d'Uranibourg." This expedition became memorable in two ways. First, because Picard, in his account of it, describes certain apparent motions of the Pole-star towards or away from the pole, of which the period was a year, and which, he says, he had noticed for about ten years. From the details given, it is evident that Picard was the first to notice the effect of aberration on the apparent place of a fixed star; and when he adds that these irregularities were in some years smaller than in others, it shows that the effect of nutation was also beginning to be felt. But it was reserved for Bradley both to discover the laws governing these phenomena and to give the correct explanation of them.

The second valuable result of Picard's journey to Denmark was that he made the acquaintance of Römer at Copenhagen, and persuaded him to go to Paris with him. Römer stayed nine years in Paris, and it was there that he in 1675 announced his discovery of the gradual propagation of light. We know from his letters to Huygens that he at once realised that this must produce aberration. Considering that he and Picard lived together at the Paris Observatory, it is rather strange that they did not compare notes and remark how perfectly this agreed with Picard's observations of the Pole-star. But Römer scarcely ever published anything, so it is not impossible that he may have noticed the agreement, and did not care to publish it.

Picard from time to time carried out various geographical operations in France, the results of which are included in his "Ouvrages de Mathématique" (1736). He was a very active observer at the Paris Observatory from 1666 to 1682, and his observations, which were chiefly made with a 9-ft. quadrant, were finally printed in Le Monnier's "Histoire Céleste" (1741). Though his work was less showy than that of his colleague Cassini, Picard deserves an honourable place in the ranks of astronomers as one of the comparatively few observers with instruments of precision in the period between Tycho Brahe and Flamsteed, and as the pioneer in the application of the telescope to this work.

Robin's Water-music.

By PROF. W. GARSTANG.

SCARCE heard amid the choral throng
  That gave the Spring its greeting,
You triumph, Robin, when your song
  Marks Summer's joys retreating;
Then, while the green leaves flame to gold,
  And rain drips o'er their embers,
You raise, above the sodden mould,
  The song of all Septembers.

Erratic, wistful, sweet and shrill,
  The grave and gay you mingle,
As changeful as the trickling rill
  That voices glade and dingle,—
    From high to low,
    Now swift, now slow,
  Like water o'er the pebbles,
    Meandering here,
    And darting there,
  To sparkle in the trebles.

    Chir'ri-tew! Ir'ri-tew!
    Wis'-yoo, Wis'-yoo!
  Wee'!—Swee'!—Tew-ay'!
    Tew, tew', tew, Psee'!
    Chirri-wee'! Tyo-to'!
Se-Wis'sy-wissy, Wis'sy-wissy, Wee'!

Until, in soft soliloquy,
  You enter realms more tender,
And drop, from heights of ecstasy,
  A falling trail of splendour,—
    Brilliant gems no casket treasures,
    Crystal tones no music measures,—
A glittering, flickering, tinkling streamlet,
Fragile as a dream.

    See, See', See, TSEE'. . . !
Choo-it'ty, Tu-it'ty, Choo-it'ty, Tu-it'ty, Choo-ee'!
    Wee-chee'! Wee-tsee' . . . !
Che-wir'rio-ir'rio-wir'rio-ir'rio-ee'!
    As rockets soar
Aloft to fall in twinkling disarray,
    As fountains pour
To break adrift in showers of glistering spray.

* * *

Tit-it'! Tit-it-it-it'! Tit'! Tit'!
Yes, Robin, yes! I must admit
(*Tit-it'-it-it'! Tit-it'-it-it'!*)
  My actions were suspicious,—
For no true gardener stops his spade
To hear a little bird's cascade
  Of music, though delicious!
But when, enraptured, down the scale
  You dance by steps so slender,
    The Nightingale's *Tyo-tyo'-tyo-tew'*,
    The Throstle's *Tirra-lirra-loo*,
      Grow pale
  Before your rich chromatic splendour!

Notes.

THE following is a list of those recommended by the president and council of the Royal Society for election to the council at the anniversay meeting on November 30:—*President:* Prof. C. S. Sherrington. *Treasurer:* Sir David Prain. *Secretaries:* Mr. W. B. Hardy and Mr. J. H. Jeans. *Foreign Secretary:* Sir Arthur Schuster. *Other Members of Council:* Mr. J. Barcroft, Sir William Bragg, Dr. A. W. Crossley, Prof. J. B. Farmer, Sir Walter Fletcher, Prof. A. Fowler, Dr. A. C. Haddon, Sir Robert Hadfield, Sir Thomas Heath, Prof. J. Graham Kerr, Prof. H. Lamb, Sir William Leishman, Dr. S. H. C. Martin, Prof. J. W. Nicholson, Mr. R. D. Oldham, and Prof. W. P. Wynne. Prof. Sherrington, who is to succeed Sir Joseph Thomson as president, is the Waynflete professor of physiology in the University of Oxford, and was formerly professor of physiology in the University of Liverpool and Fullerian professor of physiology at the Royal Institution. He was elected F.R.S. in 1893, and was awarded a Royal medal in 1905 for his researches on the central nervous system.

DR. E. H. GRIFFITHS has been elected general treasurer of the British Association in succession to the late Prof. John Perry. The council of the Association has agreed to the formation of a separate Section of Psychology, as recommended by the Sections of Physiology and Educational Science at Cardiff, and approved by the general committee. Consideration of the number and scope of the various Sections is to be referred to a special committee. It has been decided to invite national Associations for the Advancement of Science to send representatives to annual meetings of the British Association in future.

THE council of the British Association has recently had before it the suggestion made by Prof. Herdman in his presidential address at Cardiff for a new *Challenger* expedition for the exploration of the great oceans of the globe with modern instruments and methods. It will be remembered that this proposal received the support of all the Sections of the Association by formal resolution, and the council was asked to appoint a committee to take the necessary steps to urge its need upon the Government and the nation. This committee has now been appointed, and the scientific world will follow its activities and their result with close attention. An oceanographical expedition along the lines contemplated, and equipped with the instruments which modern science can provide, would lead to a great increase of knowledge both for scientific study and for profitable development, and no nation could carry it out more appropriately than Great Britain in co-operation with our overseas Dominions. There will be an eclipse of the sun in September, 1922, with the line of totality crossing the Maldive Islands, and the expedition could very well include an astronomical party to observe it. It is believed that the Admiralty is favourably disposed towards the scheme, and every scientific man hopes that the necessary support will be forthcoming to carry out the enterprise on a scale worthy of the British Empire.

MR. H. G. WELLS, who has recently been in Russia, describes in the *Sunday Express* of November 7 the position of some leading men of science whom he met at Petersburg, by which name, and not Petrograd, this city is now called. He saw Pavlov, the physiologist, Karpinsky, the geologist, Belopolsky, the astronomer, Oldenburg, the Orientalist, and Radlov, the ethnologist, among others who have survived the complete social disruption which Russia has undergone since the catastrophe of 1917–18. Such privileges as are possible in the country under existing conditions appear to be extended to scientific workers; for Mr. Wells mentions that the ancient palace of the Archduchess Marie Pavlova is now a House of Science, where a special rationing system "provides as well as it can for the needs of four thousand scientific workers and their dependents—in all, perhaps, for ten thousand people." In spite of this, however, there are much privation and misery, and unless food and clothing are provided few are likely to survive the coming winter. What struck Mr. Wells more than anything else was that even under the present disordered conditions, and with physical vitality reduced almost to its lowest limits, a certain amount of scientific work is still carried on, and there is a burning desire to know what has been done for the advancement of natural knowledge in other parts of the world since the Russian collapse. "The House of Literature and Art," we are told, "talked of want and miseries, but not the scientific men. What they were all keen about was the possibility of getting scientific publications; they value knowledge more than bread." There would, we are sure, be no difficulty in obtaining the books and publications needed by, or funds for providing warm clothing for, the great survivors of the Russian scientific world, if their colleagues here were assured that the parcels would reach their destination. This specific aid is, however, a different matter from general provision for the physical and mental needs of the "four thousand" scientific workers to whom Mr. Wells refers. We should scarcely have placed so many men in that category even before the war, and the ranks of scientific forces in Russia must have been greatly reduced by the revolution.

A GOOD deal of uneasiness has recently been manifested with regard to the free importation of German dyes into this country, and in reply to questions on this subject the President of the Board of Trade stated on November 1 in the House of Commons that proposals to protect the industry for a time, so as to enable it to be placed on a secure foundation, will be embodied in a Bill relating to key industries which will be introduced and proceeded with as soon as possible. It appears that during the first nine months of this year 1574 tons of dyes were imported from Germany, of which 877 were consigned under the reparation clauses of the Peace Treaty. The value of the whole quantity was 1,399,027*l*., and as the average price per lb. is thus about 7*s*. 11*d*. it would not appear that there can be any question of dumping as alleged in some quarters. The amount imported is at the rate of about 2000 tons per annum, whilst in 1913 there were imported from Germany about 13,000 tons. It is evident that there is a demand in this country for certain dyes of German origin, and this is not surprising when it is considered that with one conspicuous exception British manufacturers at the commencement of the war, like the Americans, concentrated their attention on the production of those dyes which were most in demand, simple to make, and required readily obtainable intermediate products. It is high time, however, that a serious effort should be made to produce such important dyes as the rhodamines and others, for which special plant and intermediate products not easy to make are required; and it may be noted that the former, in consequence of the remarkable discovery of a new catalytic method of preparing phthalic anhydride at a very low cost, are already appearing in America. Until this can be done the introduction of legislation such as that foreshadowed by the President of the Board of Trade is quite essential.

IN view of the increasing population in England and the imperative necessity that this country should in the future be more self-supporting in the matter of food than in the past, few subjects are of more vital importance than that of the reclamation of waste lands. The Association of Economic Biologists, presided over by Sir David Prain, discussed this problem at its meeting in the Imperial College of Science on Friday, November 5. In addresses very fully illustrated by lantern-slides Prof. F. W. Oliver considered the question of reclamation by botanical means and Dr. E. J. Russell that of reclamation by agricultural means. The former devoted his attention primarily to the reclamation of salt marshes and other maritime tracts, showing the manner in which this process slowly occurs in Nature through the accreting activities of certain ordered successions of plants, and then indicating how such action might be accelerated and made of immediate practical value by the wise interference of skilled botanists. Knowledge of the ecology of maritime-strand plants is, however, very small, and the necessity was emphasised for the establishment of experimental stations where such problems could be studied. Dr. Russell considered the reclamation of inland tracts of country, such as moor and fen, sandy commons, etc., and lands deficient in particular mineral constituents. Each class of waste land was discussed in turn with illustrations drawn from a wealth of personal experience, and the different procedures required in the several cases were described. Prof. Farmer, Dr. Voelcker, Mr. Lobjoit, Dr. Salisbury, Mr. Bernard Davis, and Sir David Prain took part in the discussion.

"Our Wasteful Use of Coal and a Remedy" is the title of an article by Mr. W. O. Horsnaill appearing in the November issue of the *Fortnightly Review*. The author discusses in turn various recent publications, and concludes that "it is quite evident from the foregoing facts that coal should never be burnt direct for the production of heat if the greatest economy in its use is to be realised." He mentions the proposals made by Dr. Ferranti in 1910, according to which all coal would be consumed centrally for the generation of electricity, and points out once more the fundamental weakness of any such proposal, viz. that any attempt to deal with heating by such a scheme would mean an extravagant expenditure of fuel. The author finds that "the recommendations of the Coal Conservation Sub-Committee which was appointed by the Reconstruction Committee closely accord with the suggestions made" in his article, and goes on: "Put briefly, the Sub-Committee recommendations comprise the establishment of sixteen super-electric generating stations for supplying the whole country and the gradual suppression of the existing 600 undertakings. At these stations the coal would be so treated as to extract the tar, sulphate of ammonia, and gas, the latter, together with the coke, being utilised to produce the electricity. So far as practicable, the super-stations would be established near the coal-pits." There is a lack of precision about this paragraph which is observable in other parts of the article. The soundness of treating coal for by-products at the proposed super-stations was regarded by the Sub-Committee as requiring consideration. Moreover, the position of modern super-stations is of necessity determined by supplies of condenser water, and not by proximity to coal-pits. Mr. Horsnaill concludes: "Whether the use of electricity for heating and cooking is contemplated is not clear, but, in view of heavy losses already set forth as accruing from this practice, it is to be hoped that coke and gas will be employed for these purposes"—with which surely anybody who has looked into the subject at all carefully will agree.

We are glad to welcome a new contemporary in the *Mining Electrical Engineer*, of which the first issue is now before us. This publication is the official journal of the Association of Mining Electrical Engineers, a society which has been doing important work for the last eleven years in the spreading of knowledge regarding the use of electricity in mines. Such a journal is of particular interest at the present time, when the need for the application of scientific methods to the aid of labour in improving the output of the coal-mines is so urgent, and we are pleased to see this sign of vitality in a society which from its earliest days has worked hard to break down prejudice against the use of electricity in collieries, to facilitate the interchange of experience, and to encourage those researches which conduced so much to improved safety and trustworthiness in this field. Besides some sound common sense regarding the industrial situation, there are several interesting technical articles, including a discussion of the ventilation of enclosed motors by Mr. W. M. Landon, and a fully illustrated description of an electrically driven main shaft winding plant, employing a geared three-phase motor. A complete system of electrical signalling in collieries, worked out in great detail by one of the well-known electrical firms, is also described. The proceedings of the various branches of the association are recorded, and many interesting notes on matters of electrical interest appear.

The October issue of the *Scientific Worker*—the official organ of the National Union of Scientific Workers—contains the report of the Executive Committee on the policy and administration of the Government Department of Scientific and Industrial Research. After describing the present regulation for the formation of research associations under the Department, the report condemns the policy of assisting these close corporations with public funds, and would substitute for them the universities, colleges, and other national institutions at which research has been carried out so satisfactorily in the past. The report alleges that the faults of the present arrangements are due mainly to the constitution of the Advisory Council of the Research Department and to the absence of members with first-hand knowledge of the working of modern faculties of applied science at our universities and colleges. It is held that scientific eminence should not be the only qualification for membership of the Advisory Council, but aptitude for the conduct of affairs should be essential. These questions are to be discussed at the meeting of the council of the union on November 13.

Prof. F. Gowland Hopkins is to deliver the eleventh biennial Huxley lecture on "Recent Advances in Science in their Relation to Practical Medicine" at Charing Cross Hospital at 3 o'clock on Wednesday, November 24.

During the coming session the meetings of the Röntgen Society will be held in the physics lecture theatre, University College, Gower Street, W.C.1, on the Thursday before the third Friday of each month at 8.15 p.m.

The opening meeting of the new session of the Institution of Electrical Engineers will be held on Thursday, November 18, and not to-day (November 11), as originally announced, at the Institution of Civil Engineers at 6 p.m., when the president, Mr. Ll. B. Atkinson, will deliver his inaugural address.

THE Eugenics Education Society is organising a lecture to be given by Dean Inge on Tuesday, November 16, at 5.30 p.m., at the Wigmore Hall, Wigmore Street, W.1, entitled "Eugenics and Religion." The lecture will be free and open to the public.

THE annual Huxley memorial lecture of the Royal Anthropological Institute will be delivered by Dr. A. C. Haddon in the lecture-room of the Royal Society on Tuesday, November 23, at 8.30. The subject will be "Migrations of Cultures in British New Guinea."

THE New York correspondent of the *Times* states that the fifth quinquennial election to the American Hall of Fame has resulted in the choice, from among 177 names submitted, of six, which include James Buchanan Eads, a famous engineer, and William Thomas Greene Morton, the Boston dentist who introduced sulphuric ether as an anæsthetic. Of the 27 women nominated, one, Alice Freeman Palmer, the educationist, was chosen.

THE following have been elected officers of the Cambridge Philosophical Society for the session 1920–21:—*President:* Prof. Seward. *Vice-Presidents:* Sir E. Rutherford, Mr. C. T. R. Wilson, and Dr. E. H. Griffiths. *Treasurer:* Prof. Hobson. *Secretaries:* Mr. H. H. Brindley, Prof. Baker, and Mr. F. W. Aston. *New Members of the Council:* Prof. Marr, Mr. C. T. Heycock, Mr. H. Lamb, Prof. Hopkins, Dr. Bennett, and Dr. Hartridge.

MR. ARTHUR MACDONALD has reprinted from the *Medical Times* of July last an interesting paper on "The Anthropology of Modern Civilised Man." He describes the conclusions at which he has arrived after a long course of study. He dwells upon the importance of head measurements as a test of mental ability. The smaller circumference of the head among children of mixed nationalities in America is held to indicate an unfavourable result of race intermixture. One of the main objects of the study of humanity is to lessen pain through the knowledge gained by the study of pain itself. Investigations into sensibility give some interesting results. Coloured children are more sensitive to heat than white children, and bright children as compared with dull children. All children are more sensitive to heat and locality on the left than on the right wrist, probably because the greater use of the right hand causes obtuseness of feeling. Girls are less sensitive to heat and more sensitive to locality on the wrist than boys, and all children are more sensitive to heat and locality on the wrist before than after puberty.

IN the issue of *Man* for October Mr. L. W. G. Malcolm describes a settlement of Tasmanian half-castes on Cape Barren Island, included in the Furneaux group of islands in Bass Strait, between Tasmania and the Australian continent. The settlement dates from the latter half of the seventeenth century, when Bass demonstrated that Furneaux Land was a group of islands, and not, as was generally supposed, connected with the mainland. The sealers who visited it carried off aboriginal women from Tasmania, and from them the present population has sprung. Among them Mr. Malcolm found two old men who claimed descent from aboriginal Tasmanian mothers. There were only nine families on the island, comprising in all about one hundred persons. One noticeable fact about these people is the pronounced odour of their bodies, which was decidedly fishy owing to the character of their diet. Their chief industry is catching and salting mutton-birds, which are exported in casks to the mainland. The Government provides medical attendance, and a school has been established. This survival of half-castes derived from a race now extinct is of considerable interest to anthropologists.

THE *Museums Journal* for November contains a useful history of the Winchester City and Westgate Museums by Mr. R. W. Hooley, who as honorary curator has of late been devoting much time and labour to putting the collections in order. In the course of his inquiries Mr. Hooley has made the lamentable discovery that the original bushel measure deposited in the city by King Edgar, and still in its possession only fifty years ago, is now missing.

IT is an excellent custom of the Smithsonian Institution to print as an appendix to its annual report a selection of papers covering a wide range of sciences and each of some general interest. The volume for 1917, recently received, devotes 546 pages and 242 plates to twenty such papers, of which eleven are original. Except for one original memoir and two of the reprints, all are by American authors, and about half deal with American subjects. It is scarcely possible to abstract such an assemblage, but we would direct the special attention of British readers to two of the papers—in the first place to "The Correlation of the Quaternary Deposits of the British Isles with those of the Continent of Europe," a hundred-page memoir by Mr. C. E. P. Brooks. This does not reveal a first-hand acquaintance with the deposits, but it is a most useful summary of the voluminous literature. Dr. T. Wayland Vaughan has an intimate knowledge of "Corals and the Formation of Coral-reefs," and his paper should interest the countrymen of Darwin, whose atoll hypothesis Dr. Vaughan is unable to substantiate in fact. The advocates of a new *Challenger* expedition may note his conclusion that "further investigations of the phenomena associated with coral-reefs are among the pressing desiderata of geologic research."

AN account of the round-headed apple-tree borer (*Saperda candida*) and its control is given in Bulletin 847 (1920) of the U.S. Bureau of Entomology. This insect is a Longicorn beetle which is indigenous to the United States and Canada. Its larva bores into the bark and wood of apple, pear, and quince, thus causing a great deal of injury. Certain wild trees are also affected, including crab, hawthorn, mountain ash, etc. The complete life-cycle of the insect occupies, as a rule, two years, but the developmental period may be lengthened or shortened according to locality and other factors. No easier and cheaper method of control was found than the old method of removing the larvæ from the trees with the aid of a pocket-knife, a narrow chisel, and a piece of wire. It is claimed that two men, on an average, with an insignificant expenditure for tools and materials, should be able to "worm" 500 trees per diem. Ordinary white-lead paint is a cheap and effective method for preventing the females from ovipositing on the bark.

The important question of the control of the cotton-boll weevil by means of poison is dealt with by Messrs. B. R. Coad and T. P. Cassidy in Bulletin 857 (1920) of the U.S. Bureau of Entomology. Extermination of the species is not attempted, the result aimed at being a sufficient reduction of the weevil infestation to permit of the production of a full cotton crop. About 60 per cent. of the squares which appear on the cotton plant fail to mature as bolls, and are normally shed at some time during their development. It has been found that up to a certain point the first shedding due to boll-weevil attack merely takes the place of this perfectly normal shedding, which would be encountered even if the weevils were absent. The system of poisoning advocated is intended to keep the weevils controlled to such a degree that they will not be able to do more than offset the above-mentioned shedding. The authors advise dusting the plants with calcium arsenate at the rate of 5 lb. per acre. In order to avoid injury to the foliage the powder should not contain more than 0·75 per cent. of water-soluble arsenic oxide. It appears safe to assume that, with fertile soil and a fairly severe weevil infestation, average gains of 500 lb. or more of seed cotton per acre may be expected from the treatment advocated.

We have received a copy of the Mauritius Almanac for 1920, published by the Mauritius Stationery and Printing Co. It is a large volume containing a mass of statistical and descriptive matter on all aspects of the life of the colony. The account of the agriculture is particularly full and interesting. There is a general map of the whole island, and another showing the distribution of rainfall.

The results of some oceanographical researches on the coast of South-West Africa are published by the Deutsche Seewarte in *Archiv*, No. 1, vol. xxxviii., the first part of this publication which has appeared since 1915. The work, which was carried out by the *Möwe* so long ago as October, 1911, to July, 1912, includes the investigation of depths and sea temperatures along the coast between the Orange and Kunene Rivers seawards as far as the 200-metre contour. The results are discussed by Dr. A. Franz, and include charts of the depths, water, and air-temperatures. There is also a section dealing with the distribution of pressure and winds. The work is particularly interesting in relation to variation in the strength and temperature of the Benguela current.

The degree of inaccessibility of various parts of the Arctic regions has a direct bearing on future exploration. Mr. V. Stefansson has an article on this subject, accompanied by a map, in the September issue of the *Geographical Review* (vol. ix., No. 9). By measuring distances of 500 miles northward along the meridians from the more northerly points attained by various exploring ships, an area of comparative inaccessibility is found to remain. The distance of 500 miles is chosen, on the basis of Peary's journey from Cape Columbia to the Pole, as a fair maximum possible with dog-teams from the base of supplies. By these estimates the "pole of inaccessibility" is found to be at latitude 83° 50′ N., longitude 160° W. Various modifying factors must be borne in mind. Open leads or heavy pressure ridges are great impediments to sledge travelling in several parts of the Arctic basin, while the action of currents may nullify advance or, if known and taken advantage of, may greatly facilitate progress. The question of food supply, if the traveller is "living off the country," also influences the problem. Certain areas of Arctic ice are known to be almost devoid of seals. These deserts must be avoided or crossed hurriedly. But Mr. Stefansson believes that the well-known drift across the Pole carries to this region, least accessible to man, a certain number of seals from the Beaufort Sea, where they are abundant.

As previously recorded in Nature (August 23, 1917, p. 510), certain plant remains found in the wide tract of sandstones and conglomerates on the west coast of Norway led Nathorst to assign those rocks to the Middle Devonian. Some fish remains found since, and now described by Dr. Johan Kiaer (*Bergens Museums Aarbok*, 1917–18, 2 Hefte, 1920), fully confirm this conclusion, and, though incapable of specific determination, warrant a comparison of the Norwegian rocks with the upper part of the great Orcadian group as displayed in the north of Scotland, and particularly in the more closely adjacent Shetlands. There were at least two kinds of ganoid fishes (apparently Diplopterus and Tristichopterus) existing in large numbers, and, whether they fed on other fishes or not, their presence implies the existence of a large animal and plant life for their maintenance. Some of the plants are regarded by Nathorst as aquatic, and tracks of some crustacean have been observed. The present discoveries will doubtless lead to further investigation of these rather inaccessible Devonian regions, and we may hope that remains of other animals will before long be found.

Parts 1 and 2 of vol. vi. of the Proceedings of the Indian Association of Science contain together eight papers which extend to 112 pages. Although the papers cover most branches of physics, investigations connected with the behaviour of musical instruments are most popular. Amongst these one by Prof. Raman on the variation of the bowing pressure with the pitch of the note, with the part of the string bowed, and with the speed of bowing in a violin may be noted. The observations were made with a violin moved mechanically to and fro at a constant speed over an iron track, while above it was suspended a bow in a balanced frame which allowed the pressure on the string to be varied. If the position of the point bowed is changed, the bowing pressure must vary inversely as the square of the distance of the point from the bridge. If the speed of bowing is increased, the pressure must be increased, at first slowly, then more rapidly. If the pitch of the string is changed by stopping, the pressure varies with the frequency, and is a maximum at each of the resonance frequencies of the string.

IN the course of his presidential address to the North-East Coast Institution of Engineers and Shipbuilders, delivered on October 29, Mr. A. Ernest Doxford made reference to the educational functions of the institution. The promotion and maintenance of professional proficiency are among the chief duties accepted by the technical societies. Their policy is to increase the professional knowledge of their members by fostering the interchange of useful information by the members themselves, and there would seem to be no more useful method of attaining the end in view than that of the reading and discussion of thoroughly good papers. In the more scrupulous institutions no paper appears except from the pen of a practical expert, and the information provided has to be either quite new or sufficiently up-to-date to require further dissemination and discussion. If the engineering technical societies are truly representative of engineers in the particular territory to which they refer, they represent the only people who are able to provide new information on engineering questions, and it is the self-imposed responsibility of these societies to furnish such information. Strictly speaking, a society cannot *train*; it only finds the information with which its members must instruct themselves. Mr. Doxford puts the question as to whether the technical societies do, or can, fill a place in the educational system of this country, and considers that they are unique and indispensable factors in any complete national educational system. The institution is not endowed, and Mr. Doxford considers that the members, the local engineering and shipbuilding industries, and the shipowning businesses might find some opportunity of encouraging it by contributions to an endowment fund; he does not think that the institution should appeal to the State, particularly in these times when State generosity in some directions has become dangerous.

WE have received from Messrs. Dulau and Co., Ltd., of Margaret Street, Oxford Circus, W.1, two catalogues of books which they are offering for sale. One includes a number of old French and Italian books and a collection of some seventy volumes from the library of Adam Smith. There are also four volumes which belonged to Newton, two of which contain his autograph. The other catalogue contains a list of about one thousand books on mathematical and physical sciences, many of them very old copies. Among other important items we note that one set of the thirteen volumes in which the Paris Académie des Sciences published the works of Laplace is offered for sale. There are also some early works on sundials and a number of sets of the Proceedings of various British and American scientific societies and other scientific periodicals.

Our Astronomical Column.

THE DISTRIBUTION OF THE STARS IN SPACE.—The *Astrophysical Journal* for July contains an important paper by Prof. Kapteyn and P. J. Van Rhijn on star-density in different regions of the stellar system. The authors have lately accumulated from various sources much new material on star parallaxes and motions, and state that they could not resist the temptation to attempt a general solution of the problem of the universe, though they admit that it will need revision. They adopt the parsec as unit of distance, and the magnitude at unit distance as absolute magnitude. That of the sun is $-0{\cdot}2$, while the median magnitude of all stars is $+2{\cdot}7$. The expression for the logarithm of the number of stars of absolute magnitude M per 1000 cubic parsecs in the region near the sun is found to be $-2{\cdot}394+0{\cdot}1858\,M-0{\cdot}0345\,M^2$, indicating a parabolic curve when M is taken as abscissa. This gives 0·0451 stars per cubic parsec near the sun, or 23·6 within 5 parsecs of the sun. Observation gives some twenty-seven stars in this sphere—a satisfactory agreement.

The next step is to investigate the rapidity with which the stellar density falls off with increasing distance from the sun (provisionally assumed as the centre). Curves are drawn showing the lines of various densities on a plane drawn through the galactic polar axis. For example, the line of density 0·01 (the density near the sun being unity) is distant 1300 parsecs towards the galactic poles, and 8900 parsecs in the galactic plane. Density 0·063 is reached at about half these distances.

Prof. Kapteyn has re-investigated the formula connecting parallax and proper motion. The new formula is

$$\log \pi_{m,\mu} = -0{\cdot}690 - 0{\cdot}0713m + 0{\cdot}645 \log \mu,$$

m being the apparent magnitude and μ the annual proper motion in seconds.

THE MULTIPLE SYSTEM ξ URSÆ MAJORIS.—Dr. G. Abetti contributes a study of this system to *Mem. della Soc. degli Spett. Ital.* (vol. viii., Ott., Nov., Dic., 1919). He reminds us that it was this star which Sir W. Herschel, who discovered its duplicity in 1780, used to demonstrate the extension of the law of gravitation beyond our system. On plotting the numerous observations of the last sixty years a minor oscillation clearly appears superposed on the orbital motion. This was explained by the discovery made by Wright and Campbell at the Lick Observatory in 1900 and 1908 that each star of the visible pair is a spectroscopic binary. The period of the pair A, a is 1·82 years, and their respective masses are given as 0·52 and 0·16 of the sun. The joint mass of B, b is given as 0·49 of the sun, but there is scarcely enough material to assign the respective masses of B, b. The parallax of the system is assumed to be 0·156″. If the mass of a is correct, this is about equal to the companion of Krueger 60, these being the smallest stellar masses known.

CHARLIER'S CRITICAL SURFACE IN ORBIT DETERMINATION.—Prof. Charlier showed that a certain surface divides those regions in space where there is a dual solution of the orbit problem from three observations from those where there is only one. Herr A. Wilkens gives in *Astr. Nach.*, 5067, tables for laying out this surface accurately. It suffices to give the intersection with the plane of the ecliptic, the surface being one of revolution about the earth-sun line. The curve resembles a looped *limaçon*, the double point being at the earth, the inner loop extending to the sun, and the outer one to a point 1·7844 beyond the sun on the earth-sun line produced. The table includes some other auxiliary quantities of use to orbit computers.

Physics at the British Association.

THE programme of Section A included papers of wide and varied interest, ranging over the subjects of pure mathematics, experimental physics, geophysics, and astronomy. A great deal of the time of the Section was absorbed in atomic problems, and it was in relation to these that much interesting discussion arose.

Dr. Aston gave a concise and comprehensive account of his work on isotopes, starting from his original discovery of the complex nature of neon and chlorine, and he spoke of his early attempts to separate the components of these gases. He described his very elegant modification of Sir J. J. Thomson's method of positive-ray analysis, by which it has now become possible to obtain mass spectra of the rare gases and many other elements with high dispersion of the component lines. He showed how the spectra of various elements could be analysed into groups of lines due to the individual isotopes, and the results interpreted by examining the spectra of different orders produced by atoms carrying multiple charges. In this way it has been possible to eliminate uncertainties arising from radiations consisting of compound molecules and to determine the number of components due to each element. Thus it was shown that chlorine consisted of three isotopic components, krypton of as many as six, and xenon of five, corresponding with atomic weights represented by whole numbers, taking oxygen of atomic weight 16 as standard. Hydrogen alone gave an atomic weight of 1·008, differing from an integral value, and this discrepancy could be explained by considering that the spectrum of hydrogen was due to a hydrogen atom from which an electron had been withdrawn, and which from theoretical considerations should have a mass differing by the observed amount from that of the hydrogen atom. The results thus show that the elements may be considered as being composed of these hydrogen nuclei, or "protons" as Sir Ernest Rutherford would have us call them, and we thus return to Prout's conception of the constitution of matter, modified only by the recent discoveries and ideas of modern physics.

Sir Ernest Rutherford followed with an account of his researches on the structure of the atom, starting from the point of view of radio-activity. When α-particles pass through matter they are scattered, and when they pass sufficiently near to the atomic nucleus they may even be turned back upon themselves. In such cases, at any rate with the lighter elements, the forces involved are so enormous that the nucleus may suffer disruption and charged hydrogen atoms, or protons," be torn from the nucleus. Hydrogen atoms travelling with high velocities thus appear, and can be detected by their scintillations produced on a fluorescent screen. These have been found when nitrogen is bombarded with α-particles, as have elementary projected particles of atomic weight 3, probably an isotopic form of helium. The investigation has been extended to other elements, and it would appear that the nuclei of atoms of the lighter elements can be regarded as made up of suitable combinations of hydrogen and this new isotope of helium with electrons. In the heavier elements it would seem that a condensation occurs by which is formed the ordinary helium atom of mass 4. Models were shown illustrating the possible constitution of some of the lighter nuclei, but the complete elucidation of this suggestive and ingenious line of thought must await further experiments.

The discussion of the origin of spectra directed attention to other scarcely less important aspects of atomic phenomena. Prof. Fowler opened the discussion with a masterly description of the known phenomena of spectroscopy, referring to the latest results obtained in examining and classifying the different spectral series of the elements, leaving the consideration of the theories which have been devised to explain the observations to Prof. Nicholson, who described Bohr's well-known theory of atomic radiation. This simple view is, however, insufficient to explain the complicated structure of the lines composing the series, and Prof. Nicholson outlined the extension of Bohr's theory recently developed by Sommerfeld, in which the electronic orbits are considered as elliptical instead of circular. By this extension the relations obtained by Bohr are modified so as to explain the structure of the components of the various spectral series, and the predictions of theory have been strikingly verified by the work of Paschen, whose observations also indicate that the Zeeman and Stark effects are of the magnitude to be expected by theory. Prof. W. L. Bragg directed attention to the difficulty of reconciling the above theory with X-ray observations on crystals and with the chemical evidence leading to Langmuir and Lewis's theory of atoms containing stationary electrons; and Dr. Oxley in a separate paper pointed out the bearing on the question of the magnetic properties of the atom—a subject which has hitherto not received the attention it deserves. From the magnetic evidence Dr. Oxley postulates a binding of the atoms in the hydrogen molecule by a rotating electron system—a complication which, it is to be hoped, will find some simpler substitute.

The subject of relativity was represented by two papers, one by Mr. Evershed and the other by Sir Oliver Lodge. The former paper was concerned with the observations made during the last seventeen years at the Kodaikanal Observatory on the shift of the Fraunhofer lines in the solar spectrum. The conclusion is reached that the general shift of the lines at the centre of the sun's disc and at the limb is not due to pressure, and it is suggested that the increase of shift in passing from the centre of the disc to the limb may be explained by a constant shift towards red over the disc, which is partly compensated by a shift towards violet, due to a movement of ascent radial to the sun. A comparison was drawn between solar phenomena and the results of observations in the electric arc, and the experiments of Royds were quoted as showing that the vapour density in the sun is probably less than is found at the centre of an iron arc. Mr. St. John's measurements on band lines were discussed and compared with observations made at Kodaikanal, which give values at the sun's limb nearly in agreement with the Einstein theory. There are, however, difficulties involved in fully interpreting the results on this theory, and the alternative hypothesis that motion is the sole cause was considered. This view demands an earth effect and a general recession of the iron vapour from the earth. Mr. Evershed described his ingenious experiments in which the displacements were observed by examining the light reflected from Venus. When the angle Venus-sun-earth is about 90° such observations should be crucial, for in this case we should be observing the sun at right angles to the supposed movement. The results are regarded as being favourable to the motion hypothesis, but it cannot be considered that they are as yet decisive.

Sir Oliver Lodge discussed the assumed necessary constancy of the observed velocity of light in free space as contrasted with the universally admitted constancy of its true velocity. He contended that there is no experimental evidence for the dogma that wave-fronts are concentric with a travelling observer initially situated at the source. The Michelson-Morley experiment is consistent with such concentricity, but does not necessitate it. He argued that the Einstein equations exercise no physical discrimination, and are consistent either with this mode of expression or with the FitzGerald-Lorentz conception of the contraction of matter, which was a safer mode of expressing physical results than the attempt to impose complications upon time and space. The paper gave rise to some lively discussion from the supporters of the more modern views.

Mr. F. J. M. Stratton exhibited some spectrograms of Nova Aquilæ III. recently obtained at the Lick Observatory by Mr. Moore, which show important changes taking place in the distribution of radiation from the growing disc of Nova Aquilæ. It appears that the disc given by the $H\beta$ radiation is growing at only half the rate of that given by the nebular lines N_1, N_2, while the complex bands in the spectrum corresponding with all three lines give the same multiple of the wave-lengths for the displacement of separate maxima. Moreover, the separate maxima originate in different portions of the disc, and are inclined to the normal position of spectral lines. A complex combination of expansion, rotation, and vortex motion is needed to explain the effects in terms of the Doppler principle. While the maxima remain fixed in position, the most displaced ones are growing brighter as compared with the central ones.

A further paper on astrophysics was communicated by the Rev. A. L. Cortie, who drew some remarkable comparisons between observations on solar faculæ and photographs of calcium flocculi. The occurrence of magnetic storms on the earth was attributed to the emission of electrons from low, disturbed areas of the sun, giving rise to the formation of clouds into which the earth then passed.

The programme also included an interesting paper by Prof. S. Chapman, who gave an account of some recent extensions of his work on the subject of magnetic storms. Prof. Horton described the results which he had obtained on ionisation phenomena in neon; and Prof. Whiddington showed how he had been able to detect distances of molecular magnitude by observing the variations of frequency in a thermionic-valve circuit produced by the minute changes of capacity resulting from the displacement of one plate of a condenser included in the circuit.

The reports of the Committees on Tidal Observations and on Seismology were of more than usual interest; and in the latter report Mr. J. J. Shaw referred to his recent observations on microseisms. Both communications are being published in the reports of the Association. Much interest was added to the proceedings of the Section by the opportune appearance of the new star in Cygnus. The discovery was announced by the Astronomer Royal at the first session of the Section, and reports of later observations on the new star were received during the meeting.

Chemistry at the British Association.

THE meetings of Section B at Cardiff were fairly well attended, although the programme did not contain any remarkable novelties, and the war papers, which were so conspicuous a feature of the meeting at Bournemouth, were absent. Mr. Heycock's presidential address dealt with the development of metallography, a branch of physical chemistry which owes so much to the work of Heycock and Neville, whose investigations not only opened up important new lines of research, but also set a standard of accuracy which has had a most beneficial effect on later work in metallography, especially in this country. The lesson of the intimate connection between pure science and the advance of industry was well enforced by the address. The president was able to show lantern-slides made from the original photographs of Sorby taken just half a century ago, and members were enabled to appreciate the remarkable skill of the Sheffield amateur who was a pioneer in so many branches of science.

The Section held only one joint meeting for the purpose of hearing the papers in Section A on the subject of isotopic elements. There was a very large attendance at this meeting, and the latest discoveries concerning the isotopes of the commoner elements were described with admirable clearness by Dr. Aston. It is to be regretted that no chemist took part in the discussion. The doctrine of isotopes was founded on chemical evidence, and although recent developments have come chiefly from the physical side, the subject is one of intense chemical interest, and the conclusions which have been reached, inevitable as they appear to be, call for a drastic revision of conventional ideas regarding the elements. No chemist specially associated with the work of determining atomic weights was present, or it would have been interesting to learn whether accurate atomic-weight determinations have ever been made for a single element, other than those of the radio-active group, from materials of widely different origin and geological age; whether, for example, such differences as have been observed between specimens of lead from minerals containing thorium and uranium respectively could be found between chlorides of widely differing origin so as to indicate that the isotopes of chlorine were present in a different ratio from that which has led to the accepted atomic weight of that element. The later paper of Sir E. Rutherford on the structure of the atom was also of great chemical importance, and considerations of this kind have, in the hands of Langmuir and others, been brought into direct relation with chemical facts. It is to be hoped that by the time of the next meeting of the Association chemists will be prepared to join with physicists in the discussion of these questions.

The three subjects selected for discussion on the technical side were fuel, lubrication, and non-ferrous metallurgy. Capt. Desborough's paper on industrial alcohol gave an excellent review of the prospects of production of this fuel from vegetable sources in temperate regions, and showed that, whilst the present cost of root crops grown on cultivated land is too high to allow of their profitable utilisation as sources of alcohol, the possibility of growing suitable crops on reclaimed land is by no means excluded, and figures were given to show that artichokes, sugar-beet, and a South American tuberous plant are all deserving of consideration. The use of maize in certain climates and of waste cellulose is also being studied. The experiments now in progress at the Royal Naval Cordite Factory may be expected to throw some light on the question, and the Section took occasion to pass a resolution urging on the Government Departments concerned the desirability of continuing such experiments with existing plants. Some controversial matters arose in the discussion of the Third Report of the Fuel Economy Committee, which was presented by Prof. Bone. The report includes a memorandum by Prof. Louis urging improvements in the collection and presentation of mining statistics, and these recommendations have been adopted by the Committee. The Committee further disagreed with the policy of the Fuel Research Board in regard to the regulation of the quality of gas, and insisted on the importance of the limitation of inert constituents and sulphur. The hope was expressed that a further opportunity would be afforded to the Committee to submit its views to the Board of Trade before the matter was finally settled. The policy of the Fuel Research Board was defended by a later speaker, and references were made in the discussion to the use of colloidal fuel and to the recovery of ethylene from coke-oven gas. The Section asked for the reappointment of the Committee, which has done valuable work in directing public attention to the urgent national need for fuel economy. An allied subject was dealt with by Dr. Owens in his paper on the measurement of smoke pollution as carried out by a Committee of the Meteorological Office. The methods of determining acidity in air have been improved, but a good method of estimating the amount of acidity borne by the suspended solid particles is still lacking.

The discussion on lubrication covered similar ground to that of recent meetings of technical societies. Messrs. Wells and Southcombe described the influence of small quantities of free fatty acids in lubricating oils, and Dr. Dunstan directed attention to the present ignorance of the chemical nature of mineral oils. The mode of action of acids on these oils is almost completely unknown. Mr. Tizard regarded lubrication as dependent on the formation of an adsorbing layer on the surface of the metal bearing, and mentioned curious results obtained in determining surface tension between mercury and oils by the drop method. Castor oil and glycerol have about the same viscosity, but the former is a good lubricant and the latter worthless. Mercury drops falling through castor oil remain intact at the bottom of the vessel like lead shot, whilst in glycerol they coalesce immediately.

Mr. Vogel's paper on tungsten described the methods employed in the manufacture of the metal at Widnes, and included an interesting account of the steps taken by the steelmakers of this country, when the outbreak of war deprived them completely of supplies of this most essential metal, to meet the requirements of the industry, with such success that all the tungsten needed is now manufactured at home, whilst a surplus remains for export, the quality being superior to that of the metal used before the war. Prof. Desch gave an account of the preparation and properties of ductile tungsten, and directed attention to the remarkable properties of the metal in the drawn state, a complete theoretical explanation of which is still lacking. Mr. Field's paper claimed great advantages for the electrolytic method of extracting zinc over the usual distillation process, and urged its more widespread adoption. Two short analytical papers were presented by Dr. Stanford, and the last session closed with an exceedingly interesting account by Prof. Jaeger, of Groningen, of his determinations of the surface tension and electrical conductivity of organic liquids and fused salts over the remarkably wide range of $-100°$ C. to $+1600°$ C.

The report of the Committee on Absorption Spectra, which was taken as read and not discussed, consisted mainly of an exposition by Prof. Baly of his theory of absorption. This paper might have furnished the basis of a good discussion, as the physical theory involved is novel, and criticism from both the chemical and the physical sides should be expected. Whilst numerous papers on the use of atomic frequencies and of the idea of quanta have been published in recent years, there has been no thorough discussion of such views, and most chemists have allowed the communications to pass without submitting them to any rigorous scrutiny, so that it is uncertain how far the new ideas are likely to meet with acceptance.

Cardiff afforded many opportunities for the inspection of chemical industries of varied kinds, and the Sectional excursions, which were well attended, included visits to iron- and steel-works, copper-smelting works, tinplate works, gasworks, and a rubber factory.

The Lakher Head-hunters of Upper Burma.

AT the opening meeting of the session of the Royal Anthropological Institute, held on Tuesday, October 26, Prof. F. G. Parsons, vice-president, in the chair, Mr. Reginald A. Lorrain, of the Lakher Pioneer Mission, read a paper on "Lakherland, the Home of the Head-hunters."

Lakherland lies on the border of Upper Burma, and is some twenty days' march from civilisation. The Lakhers, who are practically unknown to the civilised world, are of the Mongolian type, and chocolate-coloured. While the men wear a small loincloth only, save for a large blanket thrown round them in the colder evenings, the women wear more clothing, their garments consisting of a piece of cloth for a skirt reaching down to the ankles, while a breast-jacket nearly covers the upper portion of the body. This jacket is open at the back in order that the heavy loads the women carry should not wear out the garment. The men allow their hair to grow long, but it is fastened in a large knot on the top of the head with long brass pins. A plume of horsehair is entwined in the head-cloth to show that the wearer has taken a head. The children run about in a nude condition up to the age of ten or twelve years.

The Lakhers are skilled smiths, although their tools and appliances are of the simplest character. The forge consists of three slabs of stone, and the bellows are hollowed trunks of trees in which is fitted a plunger consisting of a circular disc fitted to a handle, feathers being attached to the rim of the disc to make the plunger practically airtight. Pottery is made by the women without a wheel. The clay, which is obtained from the white-ant heaps, is moulded between a stone held inside the pot and a hammer with rope wound over the head.

An interesting feature in a dance described by Mr. Lorrain was that the ceremonial headdress of the chief for this occasion, which is handed down from father to son, was always worn by the chief's daughter.

The dead are buried in graves immediately outside the dwelling-houses. The grave consists of a hole about 4 ft. square, but the body is placed in a small, sloping trench or tunnel underground excavated from one side of this hole. The body is pushed into the tunnel feet first, the cavity then being closed with a stone. An ornamental wooden pole, with projections or ears which distinguish by their number the sex of the deceased, is erected over the grave. Outside the village decorated memorial poles are erected. In the example described by Mr. Lorrain, one of the poles bore the horsehair plume denoting that the deceased had taken heads and the tail-feather of a cock denoting that he had carried off another man's wife, while on another pole was the skull he had taken. A third small pole showed projecting points, each representing a slave he had carried off when making raids. The animals which had fallen to his spear in the chase were represented by stones round the foot of the poles. A large, flat stone was possibly a sacrificial slab. On one side was placed a row of flat staves representing the deceased's wives.

Great value is attached to the heads of animals taken in the chase and to the heads of human beings taken in tribal wars and raids, as the possession of such is believed to give the owner not only power over the victims in the "world to come," but also ensures a permit into Paradise after the death of the one who has obtained a full set of heads. Sometimes the marriage price of a maiden consisted in part of a number of such heads of human beings, and this led to young men entering into raids upon their near or distant neighbours.

By religion the Lakhers are animists, but it would be more correct to say that they appeased rather than worshipped these spirits, which are believed to be the authors of all evil. A large tree in the centre of the village was held to be the abiding place of the most powerful spirit. At the foot of this tree was the sacrificial stone upon which cocks and pigs were sacrificed.

In the discussion which followed the paper Mr. Lorrain, in replying to certain queries raised by Col. Shakespeare, stated further that there were well-marked social distinctions between the clans. The headship of the village could be held only by the members of about six clans. Next in grade to these were the aristocratic clans, also about six in number, who could not hold the headship of the village. The lower classes comprised two grades, an upper of ten to fifteen clans and a lower of about thirty clans. Below these were the slaves. The headship of the village descended from the father to the youngest son of the chief legitimate wife: other sons became headmen of outlying villages. Mr. Lorrain had not found any regular institution of feasts similar to those held among the neighbouring Lushai, which, when given in a certain progression in the number and character of the victims, bring the giver honour in this world and favour in the world to come. He had found, however, one instance of a house in which the door had a rounded instead of a square top. The exact significance of this he had not been able to ascertain beyond that it was a privilege connected in some way with a special sacrifice.

Meteors of the Season.

THE November meteors are due to return on November 14 and 15, and, though no abundant display may be expected, Mr. W. F. Denning thinks that the shower is likely to prove fairly conspicuous. The parent comet of the meteors must have been in aphelion in 1916, and is now situated between the orbits of Saturn and Uranus, so that whatever meteors may appear this year must be at a vast distance from the cometary nucleus of the shower. The whole orbit, however, contains meteoritic particles, and observations during last century prove that this system re-appears annually at the middle of November. It is fortunate that the moon will be absent from the sky after the rising of the Leonid radiant, which occurs at about 10.15 p.m. on November 15. Probably the meteors will be far more abundant after midnight, when the radiant at $150^\circ+23^\circ$ has attained a fairly good altitude.

These November meteors belong to the swift class, moving at the apparent velocity of 44 miles per second, and, like the Perseids of August, they include flashing fireballs of the largest kind intermingled with the smallest shooting stars.

An abundant shower of meteors was observed between October 30 and November 5, and quite a large number of fireballs were seen. The meteors belonged to a radiant point in Taurus and a few degrees south-west of the Hyades, at about $59^\circ+12^\circ$. There was also another shower situated in Aries at $43^\circ+22^\circ$, which furnished a considerable number of meteors. These were slow-moving, brilliant objects, and have usually traversed long flights.

Both these showers were well observed by Miss A. Grace Cook from Stowmarket during a series of careful and prolonged meteoric observations between October 30 and November 4. Mr. F. Sargent at the University Observatory, Durham, also witnessed the fall of a number of meteors on October 30 and November 5. At Bristol Mr. Denning saw some of the meteors, and one of them, on October 30, about 7.14, was also observed by Mr. F. Sargent. The real path of this object was from about 77 to 55 miles in height, and its luminous course 110 miles at a velocity of about 24 miles per second. The radiant point was at $60^\circ+14^\circ$.

A very brilliant member of the same shower appeared on November 4 at 6.11, and came under observation by Miss A. Grace Cook at Stowmarket and by others at Bristol and Ilford. It had an extremely long path, and afforded a grand spectacle to many observers in the south of England. This was also a Taurid, and it traversed a horizontal course of about 235 miles at a height of about 63 miles from over the sea, about 40 miles east of Southwold, to over Somerset about 20 miles south of Bath. This shower of Taurid meteors is well known, but its recent display, like that on November 2, 1886, was of a rather exceptional character.

Heredity and Social Fitness.

DR. WILHELMINE E. KEY has made (Carnegie Institution, Washington, Publication 296, 1920, pp. 102) a careful study of differential mating in a Pennsylvania family. The study comprises 1822 individuals, nearly half of whom are in the direct line of descent from two pairs of German immigrants of more than a century ago. The remainder were considered in connection with the strains into which the descendants of these couples married. The research began with four young people, patients at the Institution for the Feeble-minded of Western Pennsylvania, and was followed into intricate networks of stocks. Some of the general results may be outlined. (1) The behaviour in inheritance of such qualities as far-sightedness, perseverance, and push indicates that the occurrence of these traits is due to a segregation of their determiners. (2) There was a decided decrease in fecundity in all lines, but not more marked in the socially inefficient than in the efficient. On the other hand, the survival ratios increase for the successive generations of the efficient lines, while they decrease for the inefficient lines, thus illustrating Nature's method of eliminating the unfit. (3) In migration the more efficient push into new areas, the less efficient tend to settle down. (4) The reactions of the degenerate members show that the variations in efficiency are due not to adverse conditions, or to isolation, or to lack of opportunity, but to native inability and to the mating of defective with defective. (5) Individual immigrants of high potentiality tend to marry with the better native stocks, while those of low potentiality gravitate towards inferior native stocks. The whole history emphasises the usefulness (*a*) of segregating the markedly defective, (*b*) of some colonisation scheme, together with sterilisation, for certain types of the socially unfit, and (*c*) of some expert board of control with authority to prohibit marriages of a cacogenic sort. There is danger in ameliorative methods which allow the markedly unfit to multiply and counteract natural agencies for the selection of fit strains. More positively, public opinion requires to be educated towards a keener realisation of the possibilities of establishing strong strains of efficient citizens.

University and Educational Intelligence.

CAMBRIDGE.—Mr. R. A. Fisher and Mr. A. R. MacLeod have been elected to fellowships at Gonville and Caius College, and Mr. R. O. Street, Mr. W. H. Bruford, and Mr. G. E. Briggs to fellowships at St. John's College.

LONDON.—A course of nine lectures on "A Historical Review of Meteorological Theory" will be given at the Meteorological Office, South Kensington, S.W.7, by Sir Napier Shaw, reader in meteorology in the University, on Fridays at 3 p.m., beginning on January 21 next. The course is intended for advanced students of the University and others interested in the subject. Admission is free by ticket, to be obtained on application to the Meteorological Office, South Kensington, S.W.7.

The informal meetings at the Meteorological Office for the discussion of important current contributions to meteorology, chiefly in Colonial or foreign journals, began on Monday, November 1, and will be continued on alternate Mondays, with the exception of December 27, until March 21, 1921.

DR. A. FULTON, hitherto lecturer on engineering in Dundee University College, has been appointed to the chair of engineering in the same institution.

THE Cambridge University Calendar for 1920–21 has been published by the University Press, price 20*s*. The volume contains lists of University officials, professors, lecturers, etc., and the regulations for prescribed courses, degrees, and prizes. The Tripos lists from 1911–20 are given, and also the list of degrees conferred during the year 1919–20. Some three hundred pages are devoted to notes on the individual colleges, which give all the essential information about the constitution of these bodies, the regulations for admission, scholarships, etc., together with the lists of fellows, graduates, and undergraduates attached to them. The volume is supplied with a general index, and also with a complete index to members of the University.

THE Calendar for the session 1920–21 of University College, University of London, has been received. In it will be found complete details of all the faculties of which it is composed, together with time-tables for all the courses provided and lists of the scholarships, prizes, etc., available. There is also an account of the assembly held on July 2, when the American Ambassador, Mr. John W. Davis, took the chair. The Provost of the college made his report for the session 1919–20, and mentioned that during that period the college had been the recipient of two gifts from the United States: one of 1,250,000*l*. from the Rockefeller Foundation for the promotion of medical research, and another, a collection of books on American literature, history, and institutions, from the Carnegie Endowment for International Peace. Other benefactions which were mentioned included a gift of 10,000*l*. from Lord Cowdray for the extension of the engineering school, and a grant from the Carnegie United Kingdom Trust which had made it possible to institute a school of librarianship.

DETAILS of the French Budget for 1920 are given in the *Fortnightly Survey of French Economic Conditions* of September 1. For the Ministry of Public Instruction and Fine Arts a sum of 1,067,328,770 francs is provided which will be allotted in the following way: For public instruction, 994,335,476 francs; for the fine arts, 44,008,800 francs; and for technical instruction, scholarships, etc., 28,984,494 francs. Of a total of 3,280,247,620 francs provided for the Ministry of Public Works, 128,650,830 francs is devoted to section 11, which deals with aeronautics and aerial transportation. In the section of the Budget dealing with extraordinary expenditure which is not provided for by taxation the Ministry of Public Instruction and Fine Arts is credited with a further sum of 109,175,400 francs. The Ministry also receives 129,762,000 francs for the reconstruction of schools, etc., which will be recovered under various peace treaties which have been signed; while the Ministry of Agriculture will be credited with 5,812,000 francs from similar sources for the purposes of reafforestation and the reconstruction of fences protecting State forests.

TEACHERS' Leaflet No. 9 of the Bureau of Education, Washington, illustrates the earnest endeavours now being made in the United States to place instruction in civic rights and duties upon a firm foundation. The leaflet, prepared under the direction of the Bureau's specialist in civic education, describes a series of lessons in civics for the three primary grades of city schools. Each lesson is based upon some situation of civic significance in which the child is normally to be found. The typical situations include: Riding in public conveyances; visiting public places; an accident; a fire drill; arrival of a new pupil or visitor to the school; the walk to school; the arrival of the mail; and contact with a sick person. In conversation style the children are led to give their observations and experiences, and through the teacher's interpretation and enlargements the civic significance is induced. The syllabus is replete with suggestions, dramatisation without material being especially recommended. Similar situations are dealt with in each grade, the instruction being cumulative and concentric. The proposed enlargement of the syllabus and its adaptation to the requirements of the intermediate higher grade will constitute an interesting and important experiment in civic training.

THE Department of Aeronautics in the Imperial College of Science and Technology announces an extensive series of lectures for the year 1920–21. Two full-time courses have been arranged: (1) Design and Engineering and (2) Meteorology and Navigation. The former course includes lectures on aerodynamics by Prof. Bairstow, with practical classwork under his direction; a special course of mathematics for students of aerodynamics; design lectures and drawing-office work under Prof. Bairstow and Mr. F. T. Hill; and lectures on the construction and strength of aircraft by Mr. A. J. Sutton Pippard. Engine design is dealt with by Mr. A. T. Evans, the theory of the internal-combustion engine forming the subject of a series of lectures by the director of the department, Sir Richard Glazebrook. A special course of meteorology and navigation for students principally concerned with aerodynamics is being given by Sir Napier Shaw, while in the latter half of the session Wing-Comdr. Cave-Brown-Cave will lecture on airships. The full-time course on meteorology and navigation comprises a very detailed study of meteorology with special attention to its bearing on aeronautics. The work is under the control of Sir Napier Shaw, the late director of the Meteorological Office, with the assistance of Squadron-Leader Wimperis as lecturer on navigation. The whole programme for both courses is very well arranged, and as the services of such excellent lecturers have been obtained it is to be hoped that a sufficient number of students will be forthcoming to make the courses a success and to establish firmly this new department of the Imperial College.

Societies and Academies.

LONDON.

Royal Society, November 4.—Sir J. J. Thomson, president, in the chair.—Prof. H. **Lamb**: The vibrations of an elastic plate in contact with water. The chief problem considered is that of determining the gravest frequency of a thin elastic diaphragm filling an aperture in a plane rigid wall which is in contact on one side with an unlimited mass of water. This had an interest in connection with submarine signalling. An exact solution is not attempted, but a sufficient approximation for practical purposes is obtained by Rayleigh's method of an assumed type, which gives good results if the type be suitably chosen.—Prof. H. M. **Macdonald**: The transmission of electric waves around the earth's surface.—Lord **Rayleigh**: A re-examination of the light scattered by gases in respect of polarisation. II.: Experiments on helium and argon. The light scattered by helium and by argon is investigated. It is found in the case of helium that the total light scattered is in accordance with what would be expected from its refractivity. The polarisation in helium, contrary to what was found in 1918, is approximately complete. No intensity was detected in twenty-four hours of exposure in the component vibrating parallel to the exciting beam, and certainly this component was less than 6·5 per cent. of the other. Argon polarises much more completely than any other gas examined (with the possible exception of helium), the weak component being only 0·4 per cent. of the other.—Prof. C. F. **Jenkin**: Dilatation and compressibility of liquid carbonic acid. The paper describes the measurement of the dilatation and compressibility of carbonic acid between temperatures of $-37°$ C. and $+30°$ C. and up to pressures of 1400 lb. per square inch. The measurements were made to supply accurate data for determining the starting point for drawing the $\theta\phi$ and $I\phi$ diagrams and to replace the approximate results (known to be inaccurate) given in a former paper (Phil. Trans., A, vol. ccxiii., p. 76).—W. T. **David**: Radiation in explosions of hydrogen and air. This paper contains a record of the results of experiments on the emission of radiation during the explosion and later cooling of mixtures of hydrogen and air contained in a closed vessel. The results of experiments on the transparency of the exploded mixtures are also recorded. Some of the main conclusions arrived at are as follows: (1) The rate of emission is approximately proportional to the fourth power of the absolute mean gas temperature. (2) The maximum rate of emission occurs at the point of maximum temperature. (3) The exploded mixtures are very transparent throughout cooling to radiation of the same kind as they emit. (4) The intrinsic radiance increases both with the lateral dimensions and with the thickness of the radiating layer of gas. (5) The $2{\cdot}8\,\mu$ band of steam ceases to be emitted when the gas temperature has fallen to about 700° C.—Dr. R. E. **Slade** and G. I. **Higson**: Photochemical investigations of the photographic plate. (1) It has been shown that the silver halide grain is the photochemical unit in the photographic plate. (2) A method has been devised whereby the law of photochemical behaviour of these grains can be investigated free from the disturbing effects of development, etc., which occur in the photographic plate itself. (3) From experimental results obtained a formula has been deduced which shows the relation between the behaviour of the silver halide grains, the light intensity to which they have been exposed, and the time of exposure. (4) The results show that it is impossible for the mechanism of the process to be the absorption of light in discrete quanta, and that a given amount of light energy has a greater effect photographically when concentrated into a short range of wave-lengths than when it is distributed over a large range.—Dr. E. H. **Chapman**: The relationship between pressure and temperature at the same level in the free atmosphere. The paper deals with the exceptionally high values contained in the table of coefficients of correlation between changes of pressure and changes of temperature at different levels in the atmosphere included in Geophysical Memoir 13 of the Meteorological Office, by W. H. Dines. The coefficients are computed for observations taken at random, and arranged in four groups for the year of three months each. For the layers between 4 km. and 8 km. these coefficients range from 0·75 to 0·92. It is assumed that if the observations were freed entirely from errors of measurement the coefficients would be still higher. A method is therefore worked out for correction of coefficients of correlation for probable errors of observation in measurement.—Prof. J. C. **McLennan**: Note on vacuum grating spectroscopy.

PARIS.

Academy of Sciences, October 18.—M. Henri Deslandres in the chair.—M. **Mesnager**: The applications of the Pitot tube. Remarks on the note in the last issue of the *Comptes rendus* by the late Yves Delage. It is pointed out that the three problems stated by him—transmission to a distance, independence of the experimental indications and of the support, and registration of the velocities—have already been solved, and the first two in a simpler manner. An account is given of the methods hitherto proposed, all of which would be difficult to use at sea.—M. **Hamy**: The photography of stars in full daylight. An account of some experiments carried out at the Observatoire des Bosses (altitude 4350 metres) on Mont Blanc.—H. and F. **Le Chatelier**: The mechanical properties of plastic bodies: the importance of reactivity. From a study of the torsion of glass kept at 550° C. and of steel at 825° C., it is shown that there are three kinds of deformation: an instantaneous elastic strain, which disappears on removal of the stress; a sub-permanent deformation, produced slowly and disappearing equally slowly; and, finally, a viscous deformation, produced with a constant velocity and not vanishing after release from stress.—M. **Le Prieur**: A route corrector: a new method of aerial navigation by estimation.—J. L. **de Olivar**: Correction of the lunar coordinates deduced from observations made at Montevideo of the annular eclipse of the sun of December 3, 1918.—E. **Belot**: The law of distribution of masses in the solar system, and the origin of the smaller planets.—A. **Véronnet**: Time and temperature of formation of a collection of stars in an indefinite homogeneous nebula.—L. and E. **Bloch**: The spark spectra of some elements in the extreme ultra-violet. Details of the spark spectra of antimony, arsenic, bismuth, and tin between the limits 1850 and 1400 Ångström units.—G. **Bruhat**: The specific heat of saturated vapours at low temperatures. Reply to some criticisms of M. Ariès.—P. **Vaillant**: The existence of intermediate states in the phosphorescence of calcium sulphide deduced from its conductivity.—P. **Théodoridès**: The thermal variation of the coefficient of magnetisation in anhydrous sulphates, and the theory of the magneton. The results of magnetic measurements on the sulphates of manganese, cobalt, and iron at varying temperatures are given. These are in general agreement with the magneton theory.—A. **Dauvillier**: A new theory of photographic phenomena. In a recent communication the author developed a new theory of the chemical action of cathode, β, X, γ, and ultra-violet rays. The production of photographic images is considered from the same point of view.—L. **Dubreuil**: Determination of the number of independent constituents of a system of bodies.—R. **Fosse**: The micro-chemical qualitative analysis of cyanic acid. The method is based on the crystallisation of silver cyanate from hot water. After examining the forms of the crystals, they may be used for several colour reactions.—P. W. **Stuart-Menteath**: The tectonic of the Pyrenees.—G. F. **Dollfus**: The geological probabilities of discovering petroleum in France. A summary of the trial borings made in various parts of France for coal, potash, and oil. The outlook is generally unfavourable except in the valley of the Saône.—P. **Négris**: Considerations on the Glacial period. In an earlier communication the author was led to attribute the invasion by ice and its retreat to epirogenic movements. Further direct evidence of these movements is now given.—A. **Lepape**: The radio-active analysis of the thermal springs of Bagnères-de-Luchon. Some of the springs are rich in radium emanations, figures of 26·5, 31·6, and 41·5 millimicrocuries of emanation per litre of water being recorded.—H. **Ricôme**: The orientation of branches of plants in space.—L. **Emberger**: Cytological studies of the sexual organs of ferns.—M. and Mme. G. **Villedieu**: The non-toxicity of copper for moulds in general and for mildew in particular. Copper in the form of copper-ammonio-citrate does not interfere with the growth of the spores of Penicillium or mildew.—M. **Nicolle** and E. **Césari**: The effects and constitution of the antigens.—A. **Lumière** and J. **Chevrotier**: A simple and inoffensive method of avoiding anaphylactic shock. Starting with the hypothesis that anaphylactic shock is due to the formation of a solid precipitate in the blood plasma, experiments have been made *in vitro* on mixtures of sera capable of giving flocculent precipitates. Various reagents were added to these tubes with the view of discovering a substance capable of preventing the flocculation. Of the large number of reagents tested very few were found to possess the required property, and of these sodium hyposulphite was the most suitable. Experiments on animals showed that this substance was capable of preventing anaphylactic shock, and it was further proved that sodium hyposulphite did not appear to destroy, or even to attenuate, antitoxic sera.—G. **Bertrand** and R. **Vladesco**: The distribution of zinc in the horse. Twenty-three organs of the horse have been examined for zinc, the quantities found varying from 12·2 to 98 milligrams per 100 grams of dried material. Zinc was found in every organ examined, and the proportion varied not only from one organ to another, but also in the same organ or tissue in different individuals.—A. **Němec** and V. **Káš**: The favourable influence of selenium on some moulds arising from the cheese industry.—J. L. **Dantan**: The development of the Antipathella.—M. **Delphy**: The reproduction of *Enchytraeoides enchytraeoides* and *Clitellio arenarius*.—V. **Galippe**: Researches on the presence of living organisms in cretacean, ferruginous, pyritic, and siliceous fossils.—A. **Paillot**: Immunity in insects.

Books Received.

Proceedings of the Aristotelian Society. New Series. Vol. xx. Containing the Papers read before the Society during the Forty-first Session, 1919–20. Pp. iv+314. (London: Williams and Norgate.) 25*s*. net.

The Fringe of Immortality. By Mary E. Monteith. Pp. xv+204. (London: J. Murray.) 6*s*. net.

An Introduction to String Figures. By W. W. Rouse Ball. Pp. 38. (Cambridge: W. Heffer and Sons, Ltd.) 2*s*.

Ou en Est la Météorologie. By Prof. A. Berget. Pp. vi+303. (Paris: Gauthier-Villars et Cie.)

The Volatile Oils. By E. Gildemeister and Fr. Hoffmann. Second edition. Authorised translation by E. Kremers. Vol. ii. Pp. xx+686. (London: Longmans, Green and Co.) 32*s*. net.

A Course of Modern Analysis. By Prof. E. T. Whittaker and Prof. G. N. Watson. Third edition. Pp. vii+608. (Cambridge: At the University Press.) 40*s*. net.

Electricity and Magnetism: Theoretical and Practical. By Dr. C. E. Ashford. Third edition. Pp. xii+303. (London: E. Arnold.) 4*s*. 6*d*.

A Treatise on Airscrews. By W. E. Park. Pp. xii+308. (London: Chapman and Hall, Ltd.) 21*s*. net.

First Lessons in Geography. By E. Marsden and T. A. Smith. Pp. 185. (London: Macmillan and Co., Ltd.) 3*s*. 6*d*.

Diary of Societies.

THURSDAY, NOVEMBER 11.

ROYAL SOCIETY, at 4.30.—Dr. W. G. Ridewood: The Calcification of the Vertebral Centra in Sharks and Rays.—Dr. A. Compton: Studies in the Mechanism of Enzyme Action. I. *Rôle* of the Reaction of the Medium in fixing the Optimum Temperature of a Ferment.—C. H. Kellaway: The Effect of certain Dietary Deficiencies on the Suprarenal Glands.—E. J. Collins: The Genetics of Sex in *Funaria hygrometrica*.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5 (Annual General Meeting).—J. E. Campbell: Einstein's Theory of Gravitation as an Hypothesis in Differential Geometry (Presidential Address).—H. Bateman: The Conformal Transformations of a Space of Four Dimensions.—F. Bowman: (1) The Differentiation of the Complete Third Elliptic Integral with Respect to the Modulus; (2) Note on the Intersection of a Plane Curve and its Hessian at a Multiple Point.—T. S. Broderick: Dirichlet Multiplication of Infinite Series.—L. E. Dickson: Arithmetic of Quaternions.—P. J. Heawood: The Classification of Rational Approximations.—E. L. Ince: Integral Solutions of Ordinary Linear Differential Equations.—C. Jordan: The Series of Polynomials, every Partial Sum of which approximates *n* Values according to the Method of Least Squares.—H. J. Priestley: Some Solutions of the Wave Equation.—H. Steinhaus: An Example of a Thoroughly Divergent Orthogonal Development.—N. Wiener: The Group of the Linear Continuum.—G. S. Young: The Partial Derivates of a Function of Many Variables.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. E. G. Browne: Arabian Medicine after Avicenna (FitzPatrick Lecture).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir D'Arcy Power: The Education of a Surgeon under Thomas Vicary (Thomas Vicary Lecture).

ROYAL SOCIETY OF MEDICINE, at 6.30.—Sir Almroth Wright: Medical Research, and the conditions that are indispensable to the achievement of new knowledge.

OPTICAL SOCIETY, at 7.30.—Major E. O. Henrici: The Use of Internal Focussing Telescopes for Stadia Surveying.—Dr R. J. E. Hanson: Visual Fatigue and Eye Strain in the Use of Telescopes.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Dr. H. Head, Dr. J. Collier, and Others: Discussion on Aphasia.

FRIDAY, NOVEMBER 12.

INSTITUTE OF CHEMISTRY, at 4.—To Receive Report of the Extraordinary General Meeting of October 28 and confirm the Resolutions and By-laws passed thereat.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—Dr. F. S. Goucher: Ionisation and Excitation of Radiation by Electron Impact in Helium.—J. Guild: Fringe Systems in Uncompensated Interferometers.—J. Guild: The Location of Interference Fringes.—Dr. G. Barr: A New Relay for Moderately Heavy Currents.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Rev. J. G. Hagen: Differences between Long-period and Short-period Variables.—J. H. Reynolds: The Galactic Distribution of the large Spiral Nebulæ.—W. S. Franks: Micrometrical Measures of 202 Double Stars.—F. E. Baxandall: The Presence of Absorption Lines of Nitrogen and Oxygen in the Spectra of Nova Aquilæ III.—J. van der Bilt: Observations of Minor Planets made with the 10-in. Refractor of the University Observatory, Utrecht, Holland.—W. J. S. Lockyer and D. L. Edwards: Spectroscopic and Magnitude Observations of Nova Cygni III., 1920.—G. F. Dodwell: Note on the Longitude of Adelaide.—J. Evershed: Recent Work at Kodaikanal Observatory.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.—Dr. F. Parkes Weber: Chronic Myeloid Leukæmia—Death from Acute Anæmia due to Massive Hæmorrhages (Hæmatomata), Simulation of Slight Pyuria by Leukæmic Oozing in the Urine.—Z. Cope: Diaphragmatic Shoulder Pain.

INSTITUTION OF MECHANICAL ENGINEERS, at 7.—Informal Meeting.

JUNIOR INSTITUTION OF ENGINEERS (at Caxton Hall), at 8.—R. H. Squire: Hydraulic Sand Packing and Colliery Workings in India.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—Dr. J. Taylor: Some Neurological Aspects of Ophthalmic Cases (Presidential Address).—P. Smith: The Blood-vessels in the Eye of the Ox.

MONDAY, NOVEMBER 15.

ROYAL BOTANIC SOCIETY, at 3.—Prof. A. W. Bickerton: The Relations of Astronomy to Botany. (1) The Importance of Scientific Correlation.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Prof. H. E. Schwarz: The Control of Climate by Lakes.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting) (at Chartered Institute of Patent Agents), at 7.—Ll. B. Atkinson and Others: Discussion.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—R. Dircks: The Library of the Royal Institute of British Architects.

TUESDAY, NOVEMBER 16.

ROYAL HORTICULTURAL SOCIETY, at 3.

ROYAL COLONIAL INSTITUTE (at Hotel Victoria), at 4.—G. Howell: Petroleum Resources of the British Empire.

ROYAL SOCIETY OF MEDICINE (Therapeutics and Pharmacology Section), at 4.30.—Major Acton: Pharmacological Actions of the Main Cinchona Alkaloids, illustrating their Isomeric Relationships.—Dr. W. E. Dixon: Quinine Derivatives as Local Anæsthetics.—Dr. W. Crowe: The Vaccine Treatment of Rheumatoid Arthritis.—Drs. W. E. Dixon and D. Cow: Pituitrin-like Body in the Cerebro-spinal Fluid, and Hormones which cause its appearance therein.

ROYAL STATISTICAL SOCIETY, at 5.15.—Sir B. Henry Rew: The Organisation of Statistics (Inaugural Presidential Address).

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—F. W. Macaulay: Cross Connections on the Elan Aqueduct of the Birmingham Corporation Waterworks.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—L. W. Bates: Colloidal Fuel.—H. O'Neill: Properties and Characteristics of Colloidal Fuel.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. P. Chalmers Mitchell: Report on the Additions to the Society's Menagerie during the month of October.—Dr. W. A. Cunnington: The Fauna of the African Lakes: A Study in Comparative Limnology, with special reference to Tanganyika.—H. F. Carter: Description of the Adult, Larval, and Pupal Stages of a new Mosquito from Lord Howe Island, South Pacific.—Dr. C. L. Boulenger: Filariid Worms from Mammalia and Birds in the Society's Gardens, 1914-1915.

ROYAL SOCIETY OF MEDICINE (Pathology Section), at 8.30.—Dr. H. Schutze: Blood Grouping with Dried Material and its Medico-legal Bearing.—Dr. J. A. Murray: Autoplasty after Exposure to Hot Air.—Dr. A. Powell: A Flagellate Organism persisting for Six Years in otherwise Sterile Urine.

WEDNESDAY, NOVEMBER 17.

ROYAL SOCIETY OF MEDICINE (History of Medicine Section), at 5.—J. Berry: A Public Latrine of Roman Imperial Time.—Dr. M. Greenwood: Galen as an Epidemiologist.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.

ROYAL SOCIETY OF ARTS, at 8.—A. A. Campbell Swinton: Wireless Telegraphy and Telephony (Inaugural Address).

ROYAL METEOROLOGICAL SOCIETY, at 8.—C. E. P. Brooks and H. W. Braby: The Clash of the Trades in the Pacific.—Dr. W. H. Steavenson: Note on the Mirage, as observed in Egypt.

ROYAL MICROSCOPICAL SOCIETY, at 8.

THURSDAY, NOVEMBER 18.

ROYAL BOTANIC SOCIETY, at 3.—Prof. A. W. Bickerton: The Relations of Astronomy to Botany. (2) The Value of Basic Principles.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Sir Arthur Schuster: The Absorption and Scattering of Light.—Prof. O. W. Richardson: The Emission of Electrons under the Influence of Chemical Action.—Dr. A. E. Oxley: Magnetism and Atomic Structure. I.—Prof. A. O. Rankine: The Proximity of Atoms in Gaseous Molecules.—Prof. A. O. Rankine: The Similarity between Carbon Dioxide and Nitrous Oxide.—Dr. A. M. Williams: Forces in Surface Films. Part I., Theoretical Considerations; Part II., Experimental Observations and Calculations; Part III., The Charge on Colloids.

LINNEAN SOCIETY, at 5.—Prof. E. S. Goodrich: A New Type of Teleostean Cartilaginous Pectoral Girdle found in young Clupeids.—Dr. J. C. Willis: Endemic Genera and Species of Plants.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.—L. Dumblane: The Problem of the Helicopter.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—J. Morrow Campbell: The Origin of Primary Ore Deposits (Adjourned Discussion).—H. C. Robson: Converting High-grade Matte in Magnesite-lined Converters.—C. Brackenbury: An Automatic Counting Machine for Checking Tram Wagons.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Ll. B. Atkinson: Inaugural Address.

INSTITUTION OF AUTOMOBILE ENGINEERS, at 8.—London Graduates' Meeting.

CHEMICAL SOCIETY, at 8.

RÖNTGEN SOCIETY (in Physics Lecture Theatre, University College, Gower Street), at 8.15.

FRIDAY, NOVEMBER 19.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.—Sir William Milligan: Chronic Catarrhal Otitis Media; Some Thoughts and Suggestions.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Capt. J. S. Arthur: Sterilisation of Water by Chlorine Gas.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Section) (at City and Guilds (Eng.) College, Exhibition Road), at 6.30.—C. C. Paterson: The Incandescent Electric Lamp from the Inside.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Sections), at 8.30.—Discussion: Radio-therapy; Prof. S. Russ: Physics.—Dr. Batten: Superficial Therapy.—Dr. Finzi: Deep Therapy.

SATURDAY, NOVEMBER 20.

PHYSIOLOGICAL SOCIETY (at St. Bartholomew's Hospital), at 4.

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Science and the Cenotaph.

THE second anniversary of the Armistice of November 11, 1918, has come and gone, and the whole nation, united in a common impulse of pious and grateful remembrance, has done solemn homage to the memory of the glorious dead. King and people, leaders and comrades, have paid reverence to the remains of that unknown hero who has been laid to rest in our national shrine, and who typifies the humble and silent sacrifice of those many thousands to whom we owe the survival of civilisation.

To the soldiers of science, to whom duty and self-sacrifice are, or ought to be, ever-present ideals, the ceremony of last Thursday should have made a special appeal. In the great struggle which terminated two years ago they were not backward in taking their places in the fighting organisation of the nation. With very few exceptions they put their special gifts and training at the service of the State. The devotion and fearless courage of the medical branch of the scientific profession have earned universal recognition. Thousands of the younger students in all faculties, who had, before the war, patriotically joined the Officers Training Corps, came forward in 1914 as one man and filled the gap in the supply of officers until the new armies were ready. Of the older men of science a great number joined fighting units and shared with the rest the hardships and dangers of the trenches. Many valuable lives were thus sacrificed which a wiser distribution might have spent to better advantage: one remembers a mathematician of great ability who served as an infantry officer and was killed by the explosion of a bomb store, and the tragedy of Moseley, who fell at Gallipoli. Others, again, debarred from active service in the trenches, took up work behind the lines or in the technical services—work not without its perils, as is shown by the fate of Keith Lucas and Bertram Hopkinson, two distinguished fellows of the Royal Society, both killed in aeroplane accidents, who died a soldier's death as truly as if they had fallen in action. Another well-known scientific researcher spent weeks experimenting in a submarine in a highly dangerous zone. Such examples might be multiplied a hundredfold. In gas warfare, sound ranging, air work, submarine detection, etc., a vast number of men of science were to be found, and gave their labours and their lives unstintingly. Many made the supreme sacrifice, and, on the whole, men of science proved themselves to be capable leaders and efficient organisers and administrators even in fields widely separated from those of their peace-time activities.

Scientific workers may thus join in the universal homage to the fallen with a pure heart and the consciousness of duty done. They, at all events, are free from the reproach of having in any way profited by the general suffering, or of having exploited the war for selfish ends. Whilst the cost of living still soars, and salaries and wages, in industry, commerce, and administration, try to keep pace with it, the remuneration of scientific workers, poor already before 1914, is gradually being brought down to the starvation limit, the small nominal increase given in some cases being very far indeed from making up for the decreased purchasing power of the pound.

The question not unnaturally suggests itself: How many among those silent crowds that stood bareheaded last Thursday have given any effective help even to one of the millions of returned soldiers who, in the present jostle of selfish appetites, are asking for work and bread from those whose businesses and wages they have saved? And, in particular, how many have given a thought to those struggling scientific toilers who have put away their uniforms and strive vainly to exist on inadequate salaries, under crushing taxation and to meet an ever-rising cost of living? Yet the brains of these men were no mean factor in winning the war, and it should be increasingly obvious that the salvation of a modern State, both in peace and war, must depend nowadays upon trained observation and intelligence—that is, upon science. Only impartial observation and study, such as a scientifically trained mind alone can give, will bring us nearer to the solution of the tremendous problems in sociology and economics which confront this generation. Only science can find new sources of energy for an industrial system which is largely wasting its resources in coal and oil, and, for that reason alone, is doomed to bankruptcy: a strike of miners may be settled, but what politician will settle a strike of the coal itself? How is that new and marvellous roadway of the air to be opened up and made commercially available for future generations without not merely routine technical knowledge, but also that insight of genius which is the rare gift of selected souls? And how can the heritage preserved for us by the glorious dead be defended against the dangers which all history tells us are certain to arise again if the nation has not a reserve of trained and inventive intelligence at its service?

In those days, of which the memory now seems to be fading so quickly, when the whole Empire stood thrilled and tense it was commonly repeated that we had at last become conscious of the value of science, that the old mistakes would not recur, the old neglect would be a thing of the past. We look in vain in the public Press for a repetition of such statements nowadays. We have heard of a "land fit for heroes"—but perhaps the true meaning of the phrase may have been that it would take a hero to exist in the new world. Possibly the phrases about the nation's recognition of science may have been mere words, but human beings cannot live upon such diet. The multiplication of Government Departments supposed to foster research, or of highly paid research administrators (with or without scientific qualifications), will not really recruit the ranks of true scientific workers unless something is done, and done quickly, to make the existence of such workers tolerable. That these ranks are being depleted at the present time there is ample evidence; it is becoming increasingly difficult to find suitable candidates to fill university posts, and the more responsible the posts the more difficult it is to fill them. It is clear that the better brains are being gradually squeezed out of the scientific careers. If this process goes on much longer the nation will awake one day to find that it has effectually killed the goose which laid the golden eggs.

Most of us receive daily appeals for war memorials of various kinds. Would not the best, and, in the end, the cheapest, war memorial be a growing and efficient body of brain-workers, able and willing to solve the problems which the war has left in its train, and to help the nation in its hour of need? For leaders both in peace and war we must find and train men who will be competent to use the national resources in the most effective manner. Scientific workers are naturally marked out by their progressive instincts and severe training to serve not merely in an advisory capacity in the councils of the nation, but also as executive officers. Moseley and others of his type will not have died in vain if the Cenotaph reminds us that men of science must take an active part in the affairs of State, in guiding the development and thought of the nation, and in seeing that the bitter lessons learnt during the last six years are not forgotten.

This end will not be attained by service on committees, whether for chemical warfare or any other subject. If the War Office seeks to be scientific it should establish within itself, as the Admiralty has done, a research department with distinguished men of science as permanent members of the staff to suggest and supervise work on methods of modern warfare. It would be the business of such officers to make use of science for purposes of national security, and workers in university or other laboratories could please themselves whether they co-operated or not in particular researches or experiments. We can understand the objections offered by Prof. Soddy and others against men of science associating themselves as a body with problems of this type, but until human nature reaches a higher ethical plane than it occupies at present we must have a War Office, and an essential part of it should be an able scientific staff, the members of which would be responsible for making us strong enough to meet any crises which the future might bring. No committee of sixty or more associate members can do this, and none would be necessary if the War Office ranked a scientific service with the General Staff, as it should do, instead of inviting scientific workers to devote their time and knowledge to "offensive and defensive aspects of chemical warfare" for little more than out-of-pocket expenses.

We claim for science a much more responsible position, and a far higher appreciation of its worth, than our war leaders offer to it even now; and we do so because we remember that thousands of young lives were lost through its neglect. When we bow our heads before the Cenotaph we think of the highly trained men of science who were killed at Gallipoli or drowned in the mud of Flanders while Ministers turned for advice to alchemists and circle-squarers, or confused great chemists with dispensers of drugs, and we wonder whether even now anyone in power realises what civilisation has lost through the sacrifice of creators of knowledge. While we mourn their loss, let us work and pray for the scientific enlightenment of the leaders into whose hands the destinies of the nation are entrusted, so that we may be assured of strong and effective guidance whatever is before us.

The Newer Spiritualism.

Phenomena of Materialisation: A Contribution to the Investigation of Mediumistic Teleplastics. By Baron von Schrenck-Notzing. Translated by Dr. E. E. Fournier d'Albe. Pp. xii + 340. (London: Kegan Paul, Trench, Trubner, and Co., Ltd.; New York: E. P. Dutton and Co., 1920.) Price 35*s.* net.

"OF making many books" on spiritualism "there is no end," and study thereof "is a weariness of the flesh." Certainly such is the effect of reading a ponderous and repellent volume of 200,000 words conveying the story of séances the details of which are as like one another as peas in a pod. The author describes it as "really a monograph on materialisations," since it deals, in the main, not so much with communications from the dead as with exudations from the living. These, in pseudo-scientific jargon, are defined as "ideoplastic" or "teleplastic," taking the shape of fluidic threads or psychic discharges from the mouth, armpits, and other parts of the body, sometimes returning thereto, and often accompanied by blood. Both the author and translator agree in assigning them to "a new, or, rather, a hitherto unexplored, function of certain human organisms" which have "a spiritistic interpretation" as "conductors of psychic impulses."

The book made a considerable stir in Germany on its publication in 1913; here, it was the subject of a damaging review by Miss Verrall in the Proceedings of the Society for Psychical Research, July, 1914. The translation before us was made by Dr. Fournier d'Albe in consultation with Mme. Bisson, in whose house the medium lived, and whose reports on the sittings make up the substance of the book. It is to her that the medium has "lent her remarkable powers" in return for board and residence. The real name of the medium, whose pseudonym is "Eva C.," is said to be Marthe Béraud; and while Baron von Schrenck-Notzing says that he "is not justified in publishing details concerning her personal and family affairs," he withholds nothing in respect of detail about herself, both physically and mentally. As to the latter, she is described as abnormally emotional, subject to violent outbursts of anger, very amenable to influences, and nursing illusions that her charms lead the male sex easy captives. The numerous photographs of her which are sandwiched between faked spirit photographs show that physical beauty forms no part of her attractiveness. She is, in brief, a confirmed erotic and neurotic woman, who, according to information from an independent source, nurses the belief that she is an incarnation of Thaïs.

As already said, the record of the sittings, which extended from June, 1909, to July, 1913 (they were held chiefly in Paris), has a dreary uniformity. Mme. Bisson was always present; her watchful care over "Eva C." suggests more than friendship, and awakens suspicions as to collaboration in "materialisations." The appointments were as usual; the medium sat in a dark cabinet, Mme. Bisson hopping in and out, and then joining the other sitters, rarely more than three or four, in a room dimly lighted by a red lamp; a white light, as all spiritualists agree, "acting destructively on the pseudopods or psychic projections from the medium's body." Apart from M. Richet, a somewhat credulous savant, no prominent man of science was at the sittings, save one Dr. Specht, who, after three attendances, said that he had been "shown materialisations which do not exist." Baron von Schrenck-Notzing naïvely adds: "On account of this negative attitude, Dr. Specht was not invited to further sittings." Difficulty met attempts to secure teleplasma; "Eva C." was backed by Mme. Bisson in her objections, but of the two samples which Baron von Schrenck-Notzing secured one was recognisable as human skin, and the other, under microscopic examination, a mucus-like substance, showed "cell detritis, numerous microbes, and some wool (from dress)." Convinced as he is that the teleplasmic phenomena have a "spiritual interpretation," it is to the credit of Baron von Schrenck-Notzing that he admits explanations, if only to controvert them, such as are supplied by the facts of hysterical rumination, when the patients bring up matter which they have swallowed, and of excretions due to excitation.

The reviewer can deal only with such statements as fill this book at their face value. The *onus probandi* lies on those who make them. As Faraday said in a lecture delivered before the

Royal Institution in 1854: "I am not bound to explain how a table tilts any more than to indicate how, under the conjurer's hands, a pudding appears in a hat." Baron von Schrenck-Notzing and Dr. Fournier d'Albe have a clear course before them. Let them bring "Eva C." to London to exhibit her "materialisations" before a committee of which Sir Ray Lankester, Sir Bryan Donkin, and Mr. Nevil Maskelyne should be members. Then the matter would be put beyond doubt whether the so-called evidence, thus judicially sifted, is or is not based upon the collusive action of mediums and upon the bad, because prejudiced, observation of the sitters. The need to keep in mind what Hume says about occult phenomena was never more urgent than it is to-day. "As finite added to finite never approaches a hair's breadth nearer to infinite, so a fact [statement?] incredible in itself acquires not the smallest accession of probability by the accumulation of testimony."

Boltzmann's Lectures.

Ludwig Boltzmanns Vorlesungen über die Prinzipe der Mechanik. Dritter Teil. Elastizitätstheorie und Hydromechanik. Edited by Prof. Hugo Buchholz. Pp. xiii + 608–820. (Leipzig: Johann Ambrosius Barth, 1920.) Price 21.60 marks.

THE name of Ludwig Boltzmann will live on account of his great creative work, the study of which has happily been facilitated by the publication of his collected "Wissenschaftliche Abhandlungen" (3 vols., 1909, Barth), through the co-operation of the Academies of Berlin, Göttingen, Leipzig, Munich, and Vienna. But he was distinguished also as a teacher, and his power of exposition is shown in several volumes of lectures which have appeared in print. Perhaps the best of these are his "Vorlesungen über Gastheorie" (2 vols., 1895), based chiefly on Maxwell's and his own fundamental researches on the subject. Less well known are his lectures on Maxwell's theory of electricity and light, and those on the principles of mechanics, each occupying two volumes.

The book now under review comes from the same Leipzig press, and forms a third and final volume of the lectures on mechanics. Unlike the preceding volumes, it does not come direct from Boltzmann himself; it is written, on the basis of his lectures, by one of his pupils, Buchholz, to whom Boltzmann, and afterwards his widow, allotted the work of editorship. It first appeared in 1916 as an appendix to a larger volume of Boltzmann's lectures, also edited by Buchholz, entitled "Applied Mathematics: the Mechanical Potential and its Application to the Determination of the Figure of the Earth (Higher Geodesy)." It contains the theory of elasticity and hydrodynamics which was a necessary adjunct to the geodetic part of that treatise; but its separate publication as a third volume of the principles of mechanics fulfils Boltzmann's intentions regarding the latter course of lectures, and renders it readily available to those who do not wish to study the larger work from which it is reprinted.

Boltzmann's lectures on mathematical physics formed a "cycle" unified by his use of the conception of the potential—the mechanical, electrical, and electrodynamic potentials, as in the lectures previously published, and, in the present volume, the elastic and hydrodynamic potentials. One further set of lectures remains unpublished—namely, that on the general mechanical theory of heat; in this course the thermodynamic potential is introduced and illustrated by three important examples of its application, of which Gibbs's theory of chemical equilibrium is the chief. This final instalment is at present held up owing to financial difficulties; it is much to be hoped that these may be overcome, in order to complete Boltzmann's representation of mathematical physics and in view especially of the close relation of these lectures to his work on gas theory.

Although beyond a certain point the theories of elasticity and hydrodynamics diverge widely, their kinematical foundations are almost identical, while the theory of the stress ellipsoid is as necessary to hydrodynamics as it is to elasticity when the viscosity of liquids is taken into account (though in the present volume the latter is not done). It is therefore illuminating to consider the two subjects together, and their treatment in these lectures is admirable. The explanations of the kinematical and mechanical principles are simple and detailed, and the elastic potential is then introduced and applied to a few important general problems—in particular, to the proof of the Hamiltonian principle for elastic potential energy, to the determination of the potential for various forms of crystal, and to the propagation of waves of compression and distortion in an elastic solid. This is all done in comparatively little compass—a hundred pages—and a general grasp of the subject is rendered easy by the avoidance of individual problems, such as the theory of bending in beams, or the vibrations of rods, strings, and membranes, in which the potential plays no prominent part.

The second hundred pages are devoted, on similar lines, to the general equations of hydrodynamics, the velocity potential, and the theory of wave-motion and vortex-motion. Both water- and sound-waves are discussed, including the change of form of progressive waves on water. The analogies with other branches of science are pointed out from time to time, such as, for example, that between the magnetic field of an electric current and the irrotational motion round a vortex filament. The book should be valuable both to readers approaching electricity and hydrodynamics for the first time, and to those who have studied either alone in detail. S. C.

The Surveyor's Art.

Geodesy: Including Astronomical Observations, Gravity Measurements, and Method of Least Squares. By Prof. G. L. Hosmer. Pp. xi+368. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1919.) Price 18*s.* 6*d.* net.

PROF. HOSMER'S text-books on surveying and allied subjects are well known, and any further contribution from his pen is sure of a welcome from all those either actually engaged upon, or interested in, the art of mapping the earth. We here use the word "mapping" in its complete sense—namely, as including everything requisite to the most minute delineation of the earth's surface, and of such physical quantities dependent upon its interior constitution as can be determined by surface observations.

The present book, based upon the practice and researches of the United States Coast and Geodetic Survey, is designed as a text-book for students of the higher branches of the art. We can only lament that no such volume has yet appeared based upon British surveying practice, a deficiency due partly to the fact that the great survey work of a geodetic character recently in progress in the British Empire has been that carried out by the Indian Survey Department, a body which has always trained its own staff and never summarised its methods in a text-book, and partly to the complete non-existence of any school of geodesy in this country. Should such a school ever be established, and should we ever recognise that, taking the lowest point of view, it would pay us to put the survey of our African territories upon a scientific and permanent basis, and to discontinue the present fragmentary, haphazard, and unscientific methods, the experience gained by the United States Coast and Geodetic Survey, the system it has evolved, and the body of practice it has formulated will be worthy of the closest study. On some points of detail surveyors trained in other countries would doubtless depart from the American practice, while the latter would, in other points, possibly require supplementing; there has been, for example, little occasion to develop any procedure specially applicable to very dense forest country; but on the whole the experience and skill of the American surveyors may be safely taken as guides for any future work.

We do not quite follow Prof. Hosmer in his apparent support of the now rather out-of-date search for the "figure of the earth" in the form of the spheroid which most closely fits the true surface. For convenience of calculation some spheroid must be assumed, but, provided that this is approximately true, such an approximation as is furnished by any of the well-known figures, the exact spheroid selected is unimportant. The shape of the geoid, the ultimate objective of the surveyor, can be as well represented in relation to one spheroid as to another. Great practical convenience, however, accrues if all survey systems—in any case those which have, or possibly could have in the future, a land connection—are reduced to the same conventional figure. All the North American surveys from Canada to Mexico have now adopted the Clarke (1866) figure and no further knowledge of the earth's true shape will compel them to abandon this as the basis for their reductions.

As regards the system of levels we are doubtful whether the convention adopted in the United States of applying an orthometric correction and thus defining level so that two points on an undisturbed lake are at different levels is, on the whole, the best. We should prefer to treat any points on the same equipotential surface as being at the same level, and re-define height to mean the distance of the equipotential from the geoid at a selected latitude. This is a subject which might with propriety engage the attention of the International Geodetic Congress when that body is summoned. E. H. H.

Ronald Poulton.

The Life of Ronald Poulton. By his Father, Edward Bagnall Poulton. Pp. xi+410. (London: Sidgwick and Jackson, Ltd., 1919.) Price 16*s.* net.

NOT only those who were the intimate companions of Ronald Poulton, but likewise the rest—and they were legion—who admiringly witnessed his deeds of prowess in the field, were able to realise that behind all the brilliant qualities of the outer man, the vigour and sportsmanship and grace and sheer physical beauty, there lay as the inward source of all these things a beautiful nature. One of his friends has described his personality as "radiant," and perhaps no word is better suited to convey the secret of his shining manliness. He touched nothing that he did not strike fire from, and this was because something clean and strong, like fire, burned within him.

The story of his life is written with a simple directness that enables the unfolding of his character to be observed, as it were, objectively and in the light of the accessory conditions. Enough is said to reveal a happy and populous home as the most fundamental of such formative influences. Next we see him as one of that band of "dragons" who grow up at Oxford under the genial and wisely tolerant rule of Dr. C. C. Lynam, and note that his talent for games had already been discerned by sympathetic experts. Then he goes to Rugby. If life in the English public school needs sometimes to be painted in darker colours, it is at least certain that, wherever Ronald Poulton was, vice could not show its face. He found at Rugby what the normal healthy-minded boy may surely expect to find in any of our great schools—the opportunity for an education in which the physical, mental, and moral sides of young humanity are cultivated together. The threefold result is seen in his increasing skill as an athlete; in the winning of a science scholarship at Balliol; and in a capacity for helping others that at the university, in his various boy-clubs, in business at the factory, and finally in the Army, was destined to render him, unassuming as he was, a supreme leader of men. His subsequent career, from his Balliol days onwards, shows a steady maturing of many-sided powers of social usefulness that the word "leadership" serves best of all to sum up; and, indeed, the interest that one is led to take in this aspect of his development quite overshadows the stirring tale of his football, sketched as it is by Mr. A. C. M. Croome with many fine touches. One wonders how much he might have done for England had he been spared to give the full support not merely of his wealth, which was to be great, but of his lucid intellect and nobility of soul, to the public cause which he had most at heart—the provision of a liberal education for the masses.

Of a loss that touches so many it is hard to speak fittingly, but perhaps the following passage, taken from a story by Mr. G. F. Bradby, will seem not wholly beside the point: "We say to each other, and do, no doubt, in part believe, that it is not length of days, but service, that gives to life its value, and that to die cheerfully in a great cause is perhaps the noblest use to which any man can put the life that has been given him. And all the time we are conscious of the great blank that has fallen on our own."

R. R. MARETT.

Our Bookshelf.

An Ethno-geographical Analysis of the Material Culture of Two Indian Tribes in the Gran Chaco. By Erland Nordenskiöld. Pp. xi + 295. *The Changes in the Material Culture of Two Indian Tribes under the Influence of New Surroundings.* By Erland Nordenskiöld. Pp. xvi + 245. (Comparative Ethnographical Studies, Nos. 1 and 2.) (London: Humphrey Milford, Oxford University Press, n.d.) Price 20s. net two vols.

CONSUL-GENERAL AXEL JOHNSON, of Stockholm, managing director of the Johnson Line to South America, supports in every way Swedish exploration of that continent, recognising the advantages which are sure to result from purposely conducted commercial and scientific interchange between the peoples of the respective countries. In other words, systematically gained knowledge will benefit trade. Mr. Erland Nordenskiöld is by no means the first Swedish pioneer. The first volume comprises a sifting of the present economic conditions of two still primitive tribes, the Choroti and Ashluslay of the Gran Chaco. The second volume deals in a similar way with the Chiriguans of the great Guarani group, and with the Guaranised Arawaks, both on the border between Bolivia and Argentina. Many other tribes had also to be considered as the many implements, customs, games, etc., have been traced, sometimes all over the continent, their distribution being well shown by sixty maps. The more sporadic a certain tool, the older it is, and its discontinuous occurrence is generally caused by whole tribes having died out.

The less civilised tribes copy from the richer and more advanced, not *vice versa*. The very common practice of the rape of women is one of the main influences upon the adaptation and spreading of implements and industries, since the women naturally cling to what they have been brought up with.

The chapters on the influence of the whites contain some remarkable conclusions. The positive, advantageous effect of the white culture is greater where the Indians live far away from the whites —for instance, domestic animals and things connected with them. Direct contact brings loss of independence, which ultimately spells irretrievable poverty. There is an apparently exhaustive and critically consulted bibliography. An index may be forthcoming in the contemplated third volume.

Principles and Practice of Aerial Navigation. By Lieut. J. E. Dumbleton. Pp. vii + 172 + v plates. (London: Crosby Lockwood and Son, 1920.) Price 12*s.* 6*d.* net.

ORDINARY navigation may be broadly divided into two kinds: coastal navigation, in which, shaping his course by compass, the mariner verifies his position by cross-bearings of two terrestrial objects, by two objects in transit and the bearing of a third object, and by various other methods; and navigation of the open sea, with no lights or headlands available, so that he has to depend wholly upon celestial observations. With regard to long voyages of the second type, but little progress has been made in air matters, difficulties as to obtaining a satisfactory horizon having so far proved insuperable. It is upon the development of directional wireless that the hopes of the airmen are fixed in connection with long-distance aviation in the immediate future.

It is therefore to navigation of the coastal type that the airman has given special attention, and here it is evident that not only has he availed himself fully of methods already in use, but has also not failed to improve upon these processes.

On p. 90 we have an example of this in the course and distance indicator, an instrument which from a given course and an air speed calculates the course to steer and the ground speed. So also, on p. 64, we have a most useful problem, not to be found in navigation books, for finding by three bearings of the same object the course made over the ground. As presented in the book, to be done by protraction it would seem a little complicated for use in a heavier-than-air machine, but, reduced to the form of a table, it should be of very great utility by sea or air.

The book is clearly written and altogether a highly creditable production, and should prove attractive not only to airmen and seamen, but also to all who take an intelligent interest in the development of aviation on the scientific side.

Roses: Their History, Development, and Cultivation. By the Rev. Joseph H. Pemberton. Second edition. Pp. xxiv + 334 + 9 plates. (London: Longmans, Green, and Co., 1920.) Price 15*s.* net.

THE demand for a second edition of the Rev. J. H. Pemberton's useful book on roses is a welcome sign that there are still a considerable number of keen gardeners who are interested in the genus, not so much on account of its horticultural merits, but rather because of its botanical interest. The various species of the genus Rosa, unspoilt by the hybridiser and "improver," are well worthy of cultivation, and it is to be hoped that this book will turn many to the study of the wild species, as well as to the interesting hybrids that have been derived from them.

In garden catalogues of a hundred years ago the "old-fashioned" roses were the pride of the collections, and one would like to see such collections revived, difficult as it may be now to procure some of the earlier forms.

Few people to-day have seen *Rosa hemisphaerica* in all its glory, nor do they know the beauty of the various forms of the Scotch rose, or of *R. damascena* or *R. indica.* To most, probably, the charming little rose de Meaux (*R. centifolia Pomponia*), given in the list of grandmother's roses, is scarcely known, and the same may be said of the greater number given in this interesting list of old garden favourites.

This second edition does not differ on general lines from its excellent predecessor, but a good deal has been added on the perpetual flowering musk roses, which the author himself has done so much to popularise; and on the hybrid *lutea* roses. Some useful additions have been made to the section dealing with fungus pests and to the chapters on soils and manures.

The appendix, giving a list of selected roses, has been revised, and forms a valuable guide to those who wish to grow the best types of garden roses.

Pyrometry: A Practical Treatise on the Measurement of High Temperatures. By Chas. R. Darling. Second edition, revised and enlarged. Pp. xii + 224. (London: E. and F. N. Spon, Ltd.; New York: Spon and Chamberlain, 1920.) Price 10*s.* 6*d.* net.

THE publication of the first edition of Mr. Darling's book on pyrometry in 1911 filled a want in English technical literature at a time when the value of a more exact measurement of temperature in industrial operations was being appreciated. Mr. Darling points out in his preface to the new edition that since his book was first issued there has been a great extension in the use of pyrometers in industrial processes and laboratory work, and there can be little doubt that his book has contributed in no small measure to this desirable development. He further refers to the invaluable uses of pyrometers during the war, and it is pleasing to have his testimony that British makers were fully able to meet the demand for instruments. In his revision Mr. Darling has described several instruments of the more recent pattern, and added new material, bringing the book thoroughly up to date. The bulk of the new matter is to be found in the chapter dealing with thermo-electric pyrometry, and valuable and suggestive additions have been made, particularly on the use of base-metal junctions and on protecting sheaths for couples. In the chapter on optical pyrometers there has been considerable extension, especially of the section on colour extinction instruments, the simplicity of which is a strong point.

Co-education and its Part in a Complete Education. By J. H. Badley. Pp. 39. (Cambridge: W. Heffer and Sons, Ltd., 1920.) Price 2*s.* net.

THIS is an address delivered at Cambridge on February 22 of this year to a meeting of the "Socratic" Society by the headmaster of the well-known Bedales School, with the addition of some notes, which appear at length in the appendix, bearing upon points concerning which fuller information was desired. The address takes the form of a general survey of the present position and outlook of education in this country, and of the part that co-education may be expected to play in its development.

The author defines education as the training of life, for life, by life. We must think of the child as a living organism with immense and varied possibilities. The purpose is to give these possibilities the fullest opportunity of development quite irrespective of the child's future vocation, and concerned only with the point of view of his position as an actual and potential member of the community. Mr. Badley's contention is, as a result of twenty years' experience at the Bedales residential school for both sexes, that the full value of education in its widest aspect cannot be attained for either sex unless both be taught together during the whole period of school and student life with such differentiation as physical and psychical conditions demand. It is a carefully reasoned statement worthy of the serious attention of all educators. We are face to face with the making of a new world, in the fashioning of which men and women will share equally, and in the common educational training of both sexes the problem will find its most effective solution. Such is the view of the author of this most inspiring address.

A Text-book of Electrical Engineering. Translated from the German of Dr. Adolf Thomälen. By Prof. George W. O. Howe. Fifth English edition. Pp. xi+482. (London: Edward Arnold, 1920.) Price 28*s*. net.

A NUMBER of minor alterations which have been introduced into this edition increase its value. For instance, the symbols have been modified, when necessary, so as to bring them into line with the recommendations of the International Electrotechnical Commission, and descriptions of obsolete machines have been omitted. The theory of the single-phase commutator motor has been extended, and students will find the theorems given simple and instructive. We can recommend the book to those who want a general survey of the whole elementary theory of electrical machinery.

It is assumed throughout that the alternating-current waves follow the harmonic law; this greatly simplifies the analysis. We should like the author to have laid greater stress on the limitations of the theory due to the assumptions which have been made. Owing to hysteresis, for instance, the waves do not follow the harmonic law, and although the error introduced by the assumption may be small, it makes it difficult—if not impossible—to judge of the relative merits of some of the alternative diagrams given, as they are all affected to varying extents.

We notice that the translator defines the slip of an induction motor as the difference between the number of revolutions per second of the stator magnetic field and of the rotor. It is more customary now to define it as the ratio of this difference to the revolutions per second of the stator field. Defined in this way, the slip is a pure number, and the mathematical equations of the induction motor are simplified.

Governors and the Governing of Prime Movers. By Prof. W. Trinks. Pp. xviii+236. (London: Constable and Co., Ltd., 1920.) Price 22*s*. 6*d*. net.

THIS book is probably the only one in the English language which deals exclusively with governing, the subject being usually dealt with in text-books on prime movers. The author's aim has been to produce a book of essentials and principles, put in a form which will enable the reader to judge existing and future types of governors; there are no catalogue pictures. The author does not pretend to have covered the whole field of governing; thus the mathematical side has been restricted to the usual undergraduate standard; and he projects a further volume for the use of engineers who have to make governing a life study.

Among the other subjects treated in the volume will be found discussions on the governor as a motor and as a measuring instrument, promptness and traversing time, adjustment of equilibrium speed, shaft governors, natural period of vibration of governors, interaction of the governor and the prime mover, rate-of-flow, pressure and relay governors, governor troubles and remedies. There is also a very useful chapter on discarded types of governors. In all these the treatment is clear, and there is a large number of line drawings, which will be of assistance to the student. Since there are no makers' illustrations, the book is equally suitable for British and American students, and we can recommend it with confidence.

Portraits of Scientists. 11 in. by 14 in.+margin. (The Class-room Portrait Gallery, 7 Queen Square, W.C.1.) Price 6*s*. 6*d*. each, or 30*s*. the set of five.

THESE collotype portraits have been produced with the view of meeting the need for instructive decoration in classrooms, lecture halls, and laboratories. The publishers hope that, while helping to create an atmosphere of culture, the portraits will also supply a background for much solid instruction woven around the lives of great men.

The difficulties met with, at present, in the choice and provision of artistic, decorative, and educational pictures for secondary schools and other institutions are such that any attempt at improvement in this direction is welcome. However, the paper of the present issue and the artistic effect of the portraits leave much to be desired. The series includes Galileo, Sir Isaac Newton, Michael Faraday, J. Clerk-Maxwell, and Lord Kelvin; and it is proposed to prepare a further series, incuding chemists and other men of science of to-day.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Einstein's Shift of Spectral Lines.

REFERRING to my suggestion from Gullane on p. 280 in NATURE of October 28, Lord Rayleigh has recalled my attention to Prof. Eddington's admirable report on "The Relativity Theory of Gravitation," whereby I have been reminded that the predicted shift depends not on gravitational intensity, but on gravitational potential. This makes my revolving disc quite inefficient; it would seem that bodies of astronomical size are necessary for the test.

But since the shift is proportional to the square of peripheral velocity, instead of to the acceleration, it occurs to Lord Rayleigh that the high speed of positive rays curved in a magnetic field might facilitate its detection; for, as he points out, if their speed were 10^8 c.g.s., their radiation shift would be comparable to a fortieth of an Ångström unit.

But this same proportionality to u^2/c^2 raises the question whether, after all, the shift expected is anything more than the natural consequence of self-inductive increase of inertia due to speed. If a satellite suddenly gained a spurious inertia not subject to attractive force, its orbit would enlarge and its period lengthen. So it may be with electrons in a violently projected Bohr atom.

I appreciate Dr. Chree's friendly experimental caution in your issue of November 11.

November 12. OLIVER LODGE.

The British Association.

WE have been asked by the executive of the National Union of Scientific Workers to send a contribution to the discussion in NATURE on the cause of "the apathy of local people of the educated classes to the presence of the Association" in the centres where it meets.

The majority of those who have taken part in the discussion appear to assume that this apathy is due to the failure of the Association to interest the general public in the utilitarian applications of science and their contributions to the material benefits of civilised life. Only one or two writers seem to have attempted to follow up the lead given in your editorial of September 16, which attributes the public apathy to "the neglect of national bodies like the British Association to adjust themselves to changing national needs. . . . The Association makes little endeavour to show the bearing of scientific methods and principles upon most subjects of vital importance in national polity and industrial affairs."

Prof. Soddy strikes the same note in NATURE of September 23, where he says "the vast body of the general public, disillusioned by the war, looks to them [scientific men] to provide a way of escape from the evils that threaten our civilisation." He points out that "scientific synthesis and the direction of the unique mental attitude, induced only by the actual discovery of new knowledge, to the conduct of public affairs are the real and peculiar functions of the Association if it is to regain its national position."

The executive of the union would like to endorse these views, and to suggest that it is not necessary to invoke the outstanding genius of Huxley and his contemporaries and to hold them up in invidious comparison with the men of the present day in order to explain the apathy of the public. The explanation lies rather in the message which Huxley and his contemporaries had to give to the lay public. Their appeal was not based upon holding up to public admiration the utilitarian benefits offered by science, important as these undoubtedly are. Their message appealed to the deep-seated complex of ideas, experiences, beliefs, and emotions which conditions every man's outlook on life. It challenged the static view of man's relation to his environment which was the heritage of dogmatic theology, and offered in its place a dynamic view, which revealed man as himself a part of the great stream of natural causation. As such it tore old prejudices up by the roots, roused fierce resentment in those who could not free themselves from such prejudices, and an equally fierce exultation in others who were smarting under repressions imposed by the authority of theological dogma.

Science (or, we should rather say, the bulk of the institutions and men who claim to represent science) has no such message at the present day. As is shown by the Rev. A. L. Cortie in his letter in NATURE of September 30, the sections which discussed questions such as the constitution of the atom and relativity drew good and numerous attendances; we suggest this was because these subjects touch on ideas of the nature of matter, space, and time—ideas which find a place, however vague, in the philosophy of life of a large number of people.

We believe that if the British Association and other bodies representing organised science are to regain the place in the public estimation which they held in the latter half of last century they will have to come out with a new message which, like that of Huxley and his contemporaries, challenges old-established points of view. Where the Association is to find a field ripe for such a message is suggested in your editorial and amplified by Prof. Soddy. While Huxley's message forced people to revise their old-established ideas and prejudices as to man in his relations to his *natural* environment, the public is now ripe for a lead from science in the direction of a fundamental revision of that part of its outlook on life which concerns the relations of man to the *social and economic* environment which he has created.

JOHN W. EVANS,
President.
H. LYSTER JAMESON,
Member of Executive.
A. G. CHURCH,
Secretary.

National Union of Scientific Workers,
25 Victoria Street, Westminster,
London, S.W.1, November 12.

FROM the correspondence that has recently appeared in NATURE it is evident that there is a healthy determination on the part of scientific men in Great Britain that the British Association shall not be allowed to stagnate, but must exhibit progressive evolution as well as the solid dignity implied in its full title. One point that I have recently noticed in your columns with great satisfaction is that in future representatives from similar associations in other countries will be invited to attend each meeting. We who work in parts of the British Empire remote from its centre, and are content to do so, although perhaps our scientific atmosphere is not so rarefied as some maintain, are undoubtedly apt to get out of touch, if not out of sympathy, with the work of our colleagues at home, while they are equally apt to view our endeavours as something distinct from their own, on a different, if not precisely a lower, plane, or—shall I say?—on a stage such as that on which the dogs danced for Dr. Johnson's admiration. Such misconceptions are good for no one. They ignore two fundamental facts: that science is universal, and that, nevertheless, scientific work may be undertaken on different lines, and even in a somewhat different spirit, under different conditions.

I am convinced that the British Association might do a great deal to dispel the mirage by making a feature of discussions (of course, on quite general lines) on overseas work in different branches. There are always members present at the meetings from many parts of the Empire as well as from various foreign countries, but they are too often silent members from whom expression of opinion is neither encouraged nor invited. In zoology, at any rate, what we want nowadays is not so much isolated fragments of research, however accurate the observation may be, as syntheses of results. Zoology, indeed, and perhaps other branches of biology also, are in danger of destruction by the toxins produced in their own vital processes, such, for example, as nomenclature and purely museum taxonomy. Yet comparatively few of the subjects discussed at meetings of the British Association, to judge from reports, rise much above this level. What is wanted, so far as the scientific man from overseas is concerned, is more informal discussion on fundamental subjects, more expression of reasoned opinion and well-thought-out aims as opposed to details of observation, and less of the specialist atmosphere. At any rate, that is what *I* want on the rare occasions on which I am able to attend a meeting of the British Association.

N. ANNANDALE.

Indian Museum, Calcutta, October 19.

Chemical Warfare and Scientific Workers.

PROF. SODDY has directed the attention of readers of NATURE (November 4, p. 310) to the issue on the part of the War Office of a letter in which the active co-operation of men of science is invited towards the intensive development of chemical warfare. The list of ordinary associate members embraces more than sixty names of chemists, physicists, and medical men —a list apparently drawn up without consultation with the various members concerned. On receipt of the letter referred to, I replied at once with the request that my name should be removed from the list of associate members, and in this refusal to serve I was actuated by the following considerations:

The use of poisonous gases in warfare was a nefarious novelty introduced by the Germans in violation of the conventions prescribed for civilised belligerents, and the Entente Powers had no option but to undertake methods of retaliation. During the later period of the war I acted as an associate member of the Chemical Warfare Committee, and, like many other chemists, did all in my power to assist by scientific investigation the progress of gas warfare on the offensive side. At that time my services were given most willingly. But the position has entirely altered now that the war is over. My present point of view is that I do not think it right that men of science should, two years after the armistice, be approached with the request to undertake work on a method of conducting warfare which has not yet been recognised as legitimate.

If gas warfare is to be adopted in the future, one result follows of necessity: every nation will be compelled in self-defence to cultivate this form of devilry. Yet we have just listened to the earnest appeal of the Prime Minister for more goodwill amongst nations, amongst people, amongst the classes! The recognition of chemical warfare even on the basis of a peace organisation must certainly engender an atmosphere of suspicion. It will, however, be the hope of many that if nations will by mutual consent unite in the abolition of an instrument which adds so much to the horrors of war, they will also have the strength and the determination to make their decision effective.

The successful development of chemical warfare will obviously be dependent on scientific work, and it is easily understood that the authorities should look to the universities to give them some assistance in its prosecution. University teachers should be on their guard before they bind themselves to a policy in the framing of which their opinion as a body has never been taken. Surely the universities ought to have been asked their views. Why should a professor of chemistry by joining the Chemical Warfare Committee pledge his university to a course of action of which the university may not approve?

ALEX. MCKENZIE.

PROF. SODDY (NATURE, November 4, p. 310) seems to have overlooked some arguments. Lack of preparation for war is no guarantee against an aggressive policy. Recent British history shows a close correlation between Jingoism and military inefficiency. In this country Jingoes are seldom intelligent enough to provide against the risks they incur.

Again, the more scientific war becomes, the more difficult it will be to wage it without the consent of scientific workers. If they really desire a saner state of international relations, scientific workers should seek so to develop the engines of war that they alone can use them.

Lastly, if Prof. Soddy really wishes to stop the application of science to warlike purposes, he should surely welcome with open arms the War Office Committee. Can he suggest any means for discouraging the application of scientific study to war (or to any other problem) so entirely efficient as the placing of the matter in the hands of a large Governmental Committee composed exclusively of eminent persons?

NORMAN R. CAMPBELL.

November 9.

British Laboratory and Scientific Glassware.

PROF. BAYLISS in his letter published in NATURE of November 4 appears to attribute the breakage of British laboratory glassware, when exposed to changes of temperature, to inadequate annealing, citing table glassware as an example of a commercially well-annealed article.

I have at different times examined many hundreds of pieces of table glass under the polariscope, and have never yet found one entirely free from strain. On the other hand, I have often found laboratory beakers, taken at random from average samples, in which no strain whatever can be detected. When strain does occur in beakers and flasks it is generally at the lip, and is caused by the flanging operation. In this connection it is interesting to note that beakers which contain bad striæ, and are, consequently, in a state of strain which cannot be removed by annealing, give figures for thermal endurance as high as those obtained from beakers free from striæ.

The difference in thermal endurance between German and English laboratory glassware is inherent in the composition of the glasses selected for their manufacture. The predominant factor controlling the variations in thermal endurance is the coefficient of expansion of the glass, since this property changes far more rapidly with a change of composition than do the other properties, diffusivity, tensile strength, and Young's modulus, which make up the thermal endurance of the glass. The coefficient of expansion of German laboratory glassware is something more than 10 per cent. lower than that of English, and this fact alone would account for the breakage of the English glass with drastic heat treatment.

There is no particular difficulty attached to the manufacture of glass having a low coefficient of expansion and high thermal endurance, and we may take it that the English manufacturers have decided that the maximum resistance to attack by reagents is to be desired, and have, accordingly, sacrificed thermal endurance to a small extent in order to obtain the encouraging results outlined in Mr. Jenkinson's letter in Nature of October 28.

The whole question is largely one of general policy. If the chemists of this country prefer to use a glass of higher thermal endurance but with less resistance to reagents, then I have little doubt that the British makers would supply it. E. A. Coad Pryor.

Milford, Park Road, Teddington, November 8.

The Separation of the Element Chlorine into Normal Chlorine and Meta-Chlorine, and the Positive Electron.

In commenting on a letter under the above heading from Prof. Harkins in Nature of April 22 last, I remarked that his assumption that "the hydrogen nucleus or the positive electron has, according to these papers, a weight, and presumably a mass, of 1·000, on the basis of oxygen as 16·000," was contradicted by experiment.

Prof. Harkins has pointed out to me that this assumption was made with the reservation "whenever the positive electron is combined in a complex atom," which I was careless enough to overlook. I wish, therefore, to apologise for my remark and withdraw it unreservedly.

I very much regret that this apology comes so late, but the delay is due to the fact that Prof. Harkins led me to understand that he was himself publishing a statement on the matter in Nature, to which I could reply. He now tells me he has decided not to do so. F. W. Aston.

Trinity College, Cambridge, November 9.

The Stereoscopic Appearance of Certain Pictures.

In going round a picture gallery it will be noticed that in certain pictures the objects delineated appear to stand out in a similar manner to those seen with a stereoscope. A picture of this kind has the effect of making those surrounding it appear very flat by comparison. This appearance is not the characteristic of a particular artist, because in an exhibition, all the paintings being by one man, only one or two may be found which have this stereoscopic appearance.

The majority of the pictures will be correct in drawing, perspective, light and shade, but it will be noticed that this will be correct only for one eye—that is to say, the picture is quite correct for either eye when the other is closed. Those pictures, however, which have a stereoscopic appearance are painted so that the representation is as nearly as possible a delineation as seen by the combined retinæ, any disturbing element which would do away with this illusion being eliminated. For instance, a revolver pointed straight at a person so that the centre of the barrel is pointing directly between the two eyes will be seen quite differently with the two eyes. When the right eye is closed the left-hand side of the barrel will be seen, the right-hand side being invisible. When the left eye is closed the right-hand side is seen, and the left-hand side of the barrel is invisible. When, therefore, the barrel of the revolver is foreshortened and both sides are visible, the muzzle being pointed directly at the observer, the appearance is such as could be seen only with both eyes. The stereoscopic appearance is then very striking, and the revolver appears to follow the observer and to be pointed directly at him, no matter what position he takes up with regard to the picture. In all the pictures or portions of them which present this stereoscopic appearance it will be noticed that the appearance as seen by both eyes is represented, the left-hand side of the picture being represented as seen by the left eye, the right-hand side as seen by the right eye.

In a demonstration which I gave before the Physiological Society (*Journal of Physiology*, vol. xlviii., 1914) I showed that the perception of binocular relief is independent of double images and the stimulation of disparate points, provided that the object presents images to the two retinæ similar to those which are presented by an object in the field of vision. This can be shown by taking a pair of stereoscopic photographs in which the point of sight is at the centre of each and cutting them vertically in two, and then, having pasted the left half of the left photograph on the left side and the right half of the right photograph on the right side on white or black cardboard at an appropriate distance, so that there is no overlapping when placed in the stereoscope, a picture in striking relief is obtained when combined together in the stereoscope. In this case it will be noticed that there is no portion common to both fields of view. In each case the overlapping portion is combined with white. It seems probable that this is how binocular vision takes place in ordinary circumstances. If an object in high relief—as, for instance, a vase or the face of a person—be viewed at a short distance and one particular point fixated, it will be noticed that the right eye dominates the right side of the field of vision and the left eye the left side. The image seen is almost entirely that of the right eye for the right side and that of the left eye for the left side, as may be proved by noticing the relation of surrounding objects, and closing first one eye and then the other alternately. F. W. Edridge-Green.

The Energy of Cyclones.

It does not seem to me as though any really satisfactory theory has yet been put forward to explain the genesis and maintenance of cyclones; I fully agree with Mr. Deeley (November 11, p. 345) that they are not due to contiguous masses of air at different temperatures, but, on the other hand, I do not see how they can originate in an inert and stable region like the stratosphere.

Were storms produced by contrasts of temperature —or, in other words, by the so-called polar front—surely they would be most violent where the contrast was most marked. The stormiest parts of the world are the great belt of the southern ocean from 40° to 60° S. lat. and that part of the Atlantic which lies north-west of Scotland, and neither of these regions shows any exceptionally steep gradient of temperature.

Observations in the upper air have shown a remarkable uniformity in the mean temperature (mean with regard to height) from 0 to 20 km. in every place where they have been obtained, and it follows as a corollary that there is a very uniform pressure at 20 km. height over the globe, for the pressure at 20 km. is almost independent of the surface pressure.

Observations over Europe, the only part of the world where they are numerous enough for the purpose, have also shown a most extraordinarily close correlation between the temperature and pressure of the air in the upper part of the troposphere, many of the coefficients exceeding 0·90. These facts must be reckoned with in any theory about the formation of cyclones.

My own belief is that pressure differences originate in the upper half of the troposphere from variations in the strength of the surrounding winds. Being given the means of originating and maintaining a difference of pressure at about the height of 9 km., the rest of the phenomena follow readily. The distribution of temperature, the high positive correlation below and the negative correlation above, and the rise and fall of the tropopause between cyclone and anticyclone are all explained by the vertical motion of the air that would naturally follow from the distribution of pressure. W. H. Dines.

Benson, November 12.

Physiological Method as a Key to the Causation of Isle of Wight Disease in Bees.

In the summer of 1918, while working with Prof. L. Hill and Mr. T. A. Webster on gas research, I advised Dr. John Rennie, of the natural history department of the University of Aberdeen, that a physiological study of metabolism in healthy bees and in bees known to be suffering from symptoms of Isle of Wight disease should be undertaken, making use of oxygen and carbon dioxide determinations. As a corollary, an investigation into the temperature of bees, healthy and unhealthy, was also indicated.

In the summer of 1919 it was found that apparently bees infected with Isle of Wight disease consumed in a given time much less oxygen than healthy controls. This observation was not reported to me until July, 1920, when I was able at once to draw the conclusion that the symptoms of Isle of Wight disease were due to blocking of tracheal tubes and anoxæmia. Loss of the power of flight was to be expected, as the co-ordinating nervous mechanism and the musculature involved were deprived of their proper oxygen supply.

Had I been made acquainted with the results of a research I had advised, or had the investigator been able to draw a very simple physiological conclusion from the data, whether the data were correct or erroneous, the discovery of a parasite as the blocking agent or disturbing factor in tracheal tubes would have been the natural consequence.

In 1920 this parasite was discovered by anatomical study, and its presence as the agent causing the disease is announced in the Press as the outcome of the researches of Dr. John Rennie, Mr. P. Bruce White, and Miss Elsie J. Harvey.

It will be noted that the physiological method of investigation could have led equally surely to the discovery of the parasite and to the interpretation of the symptoms. James M. McQueen.

Halesowen, November 5.

Luminosity by Attrition.

I am very glad that Sir Ray Lankester has again directed attention to this phenomenon. By a slip of the pen he says (November 4, p. 310) "quartz pebbles" in his first paragraph and in the heading. My object in writing is to say that these pebbles may be found on any shingle beach, and may be known by their translucent appearance under a "rotten" (or pitted) exterior. They are *pale* brown, and, when dry, look like lumps of derelict toffee. But on the shingle beaches of South Devon (notably the "Budleigh Salterton Pebbles"), the Chesil Beach, and the Suffolk coast (notably at Aldeburgh) practically every pebble on the beach will "flash."

It is much to be desired that some mineralogist should take up the intensive study of flint, chert, and quartzite. I may mention that for many years I have stored every "peculiar" flint pebble I have come across, and my entire collection is at the service (as a gift) of any museum worker who cares to undertake the study. Edward Heron-Allen.

Large Acres, Selsey Bill, Sussex,
November 12.

The recent letters in Nature from Lieut.-Comdr. Damant and Sir E. Ray Lankester recall some observations made in 1916 in collaboration with my friend and former headmaster, the late Mr. W. P. Workman, who first directed my attention to this interesting phenomenon. Specimens of translucent quartz from a quarry about three miles from Tintagel, North Cornwall, give the characteristic orange-coloured light in broad daylight and the peculiar smell. This *triboluminescence* of quartz was observed by Du Fay in 1735, and about 1748 Delius mentioned the sulphurous smell which accompanies the glow when quartz is rubbed against quartz (Kayser, Bd. iv., pp. 614, 617; Winkelmann, Bd. vi., p. 809).

The following observations present, I believe, some points of novelty: (1) Luminescence is produced when quartz is rubbed by any material, such as topaz or sapphire, which is harder than itself. Dr. Gordon, head of the geological department of King's College, London, kindly lent a number of minerals for the purpose of this test. Ordinary steel, which falls below quartz in the scale of hardness, does not cause the glow. (2) Fused quartz, as supplied by the Silica Syndicate, gives a very fine effect. I have on several occasions shown this as a lecture experiment by rubbing together two tubes of transparent fused silica. In this connection the observation of Lord Rayleigh (Nature, vol. civ., p. 153, 1919) that "silica glass" possesses a remarkable crystalline or quasi-crystalline structure is of special interest. (3) The tubes of fused quartz when rubbed together give the same peculiar odour as ordinary quartz pebbles.

It should, therefore, be possible to carry out an experiment of the kind suggested by Sir E. Ray Lankester by grinding the interior of a quartz vessel which might be highly evacuated or contain suitable liquid or gaseous reagents. According to Lord Rayleigh's experiments (Royal Society, February 27, 1919), the clearest and whitest quartz has some power of scattering light, though much less than that of glass or liquids. This small scattering is considered to be due to inclusions, as in the case of visibly smoky or yellow quartz. May not the presence of minute diffused metallic particles, or perhaps particles of silicon itself, be the cause of the various phenomena under discussion? H. S. Allen.

The University, Edinburgh.

Contractile Vacuoles.

There is no doubt that the explanation of the production of these vacuoles as given in Nature of November 11 by Prof. Henry H. Dixon is the correct one. It may perhaps be of interest to Prof. Dixon to refer to a paper by W. Stempell published in 1914 in *Zoolog. Jahrb., Abt. allg. Zool. u. Physiol. der Tiere* (Bd. 34, iii., p. 437), where the same view is put forward. I believe that this journal is not very accessible—a fact which doubtless accounts for its having been overlooked. I may say that it is my custom to teach this view, and a brief account will be found on p. 162 of my "Principles of General Physiology." W. M. Bayliss.

The Mechanics of Solidity.

THE subjoined table appears to indicate that the mechanical "hardness" of a solid is fairly closely related to its thermal expansion coefficient. There are exceptions like "invar," and for various reasons attention should be directed more to the scope of the relationship than to particular discordances between the hardness figures.

Comparison between Mean Linear Expansion and Three Scales of "Hardness."

Material	Thermal expansion coefficient × 10⁶	Hardness: Moh's scale	Hardness: Auerbach's "absolute" scale	Hardness: Brinell scale
Diamond ...	1·1	10·0	2500	
Topaz ...	7·0	8·0	525	
Beryl ...	5·0	7·8		
Arsenic ...	5·6	3·5		
Tourmaline ...	7·3	7·3		
Garnet ...	8·5	7·0		
Common glass	7·1	6·5	300	
,, ,,	8·8	4·5	200	
Iridium ...	7·0	6·0		217·0
Silicon ...	7·6			240·0
Rhodium ...	8·5			156·0
Platinum ...	9·0	4·3		44·0
Antimony ...	11·5	3·3		58·0
Marble ...	11·7	3·0		
,, ...		4·0		
Palladium ...	11·8			61·0
Iron	12·1	4·0	280	97·0
,, ...		5·0		
Cobalt ...	12·4			86·0
Nickel ...	12·8			144·0
Bismuth ...	13·5	2·5		14·0
Gold	14·4	2·5	97	33·0
,, ...		3·0		
Tellurium ...	16·7			27·0
Copper ...	16·8	2·5	95	53·0
,, ...		3·0	143	
Silver ...	19·3	2·5	91	37·0
,, ...		3·0		
Zinc	21·0			45·5
Tin	22·3	1·5	11	15·6
Aluminium ...	23·1	2·0	52	24·7
Magnesium ...	26·9			38·3
Lead	29·2	1·5	10	6·9
Thallium ...	30·2			7·3
Cadmium ...	30·7			29·0
Selenium ...	36·8			75·0
Rock salt ...	40·4	2·0	20	
Indium ...	41·7			1·0
Ice	52·8			
Sulphur ...	64·1	1·5		
,, ...		2·5		
Sodium ...	72·0			0·07
Potassium ...	83·0			0·03
Wax	60·0	0·2		
Indiarubber ...	200·0			

It may, perhaps, be inferred that engineers would be well advised to scrutinise "solidity" more closely, and to make use of the simple physical constants of a metal as criteria of quality in preference to developing a chaos of complicated tests which bear as little relation to each other as they do to any practical service in which metals are employed.

The Brinell hardness measurements are taken from a paper by Prof. C. A. Edwards (Inst. of Metals, 1918); the others from Landolt-Börnstein's tables.

J. INNES.

12 Edward's Road, Whitley Bay,
Northumberland, November 8.

The Protection of Animal and Bird Life in Australia.

I AM directed by the Hon. the Minister of Industry, who is the Minister controlling the Animal and Bird Protection Act in South Australia, to say that his attention has been directed to a note in NATURE of July 1 last, p. 558, in which the following quotation from a report from Mr. C. M. Hoy, of the Smithsonian Institution, appears: "There are very few game laws in Australia, and no one gives any attention to the ones that are in order." The Minister has communicated with the Smithsonian Institution, expressing regret that Mr. Hoy should have made such a statement, knowing, as he must, that so far as it applies to South Australia it is not correct that "no one gives any attention" to the laws that are in order.

We have an Animal and Bird Protection Act with very wide powers, and every effort is being made to carry out this law. We realise, of course, that in our out-back areas, where the population is very sparse, the law may not always be observed. At the same time, however, a special check is kept on persons dealing in skins and furs, and, generally, we have every reason to believe that the laws relating to the protection of animals and birds are fairly observed.

The very fact that Mr. Hoy was unable to collect a single protected animal or bird, or the nest or eggs of the protected birds, without a permit signed by the Minister of Industry, and that this permit was distinctly limited, inasmuch as it was issued subject to the condition that "no more than four examples of each totally protected species of native animal or bird are to be taken, excepting the common opossum, of which twelve (12) may be taken. No specimen of the Toolach wallaby (*Macropus Greyi*) is to be taken under any circumstances. Not more than twelve (12) examples of partially protected birds and animals," is ample evidence that Mr. Hoy knows that action is being taken in South Australia to compel the observance of these game laws. The Minister desires me to add that he trusts in the circumstances you will give publicity to his protest against Mr. Hoy's statements.

W. L. SUMMERS,
Secretary, Ministry of Industry.

Adelaide, South Australia, September 21.

New British Oligochæta.

IN revising my material and records of the Lumbriculidæ I find that two new species may now be placed on our list of indigenous annelids. These are *Rhynchelmis limosella*, Hoffm., and *Stylodrilus heringianus*, Clap. Respecting the former Beddard wrote in his "Monograph of the Order Oligochaeta" (1895, pp. 215–16): "I have seen a specimen from some part of England, but cannot give any details. There is every probability that it is a native of this country." It reached me some time ago from Ringwood, Hants.

Stylodrilus heringianus was first found near Brougham, in Cumberland, in March, 1911, but, being immature, there was an element of doubt as to its identity. In April, and again in November, of the same year I found it in two different localities near Swadlincote, Derbyshire. Our British list of Lumbriculidæ, therefore, now numbers seven species under four genera. These are *Lumbriculus variegatus*, O. F. M.; *Trichodrilus cantabrigensis*, Bedd.; *Stylodrilus Vejdovskyi*, Benh.; *S. gabretae*, Vejd.; *S. Hollissyi*, Southern; *S. heringianus*, Clap.; and *Rhynchelmis limosella*, Hoffm.

HILDERIC FRIEND.

"Cathay," Solihull.

Microscopy with Ultra-violet Light.

By J. E. BARNARD.

THE microscope is now so widely used in all branches of science and in industry that it is not surprising to find an increasing demand for greater optical efficiency. It must be admitted that in comparatively few cases is the instrument used under such conditions as to secure the best possible result; but this is due to lack of appreciation of the principles involved, and will be remedied only by a wide educational effort. Even when the greatest optical efficiency is secured, the limitations are soon felt. The chief need is for increased resolution, that factor on which the delineation of minute structure depends. Advances of great value have been made in methods of rendering visible minute objects, but it must be clearly realised that, while this greater visibility can be secured, no information as to the form or structure of objects which are below the resolution limits is to be obtained by this means. Increased magnification is by some workers still regarded as desirable, but unless this is accompanied by proportionally increased resolution, the results are worse than useless, and can lead only to serious errors of interpretation.

Two factors mainly govern resolution—namely, the numerical aperture of the objective, and the mean wave-length of the illuminant. No increase of numerical aperture has been obtained since the classic researches of Abbe, resulting in the production of apochromatic objectives; and in the present state of knowledge there appears little likelihood of any substantial advance in this direction. By using light of short wave-length, a promising field of research is at once opened up. An increase of resolution is obtained even with visible light if the violet or blue end of the spectrum is utilised, but the increase is much more definite if ultra-violet light is used, although the image is no longer a visual one.

The computation of microscope objectives for use with ultra-violet light presents considerable difficulties, as only two substances sufficiently transparent to these radiations are available—quartz and fluorite. So long ago as 1860 Spencer in America used fluorite for this purpose, and at a much later date Boys in this country suggested the possibility of using fused quartz. In 1904 Kohler, of Jena, succeeded in computing objectives entirely of fused quartz, some earlier ones which were fluorite-quartz combinations being thereby superseded. Ultra-violet light, therefore, became available for microscopic work, but the practical difficulties in the use of the apparatus are so considerable, calling for almost more knowledge of physical than of microscopical methods, that it has been used by few.

The results obtained, particularly in biological work, are in many cases of great interest, as, in addition to the advantages already indicated, there is the further important point that organisms are dealt with and photographs obtained of them in the living state. The classic researches of Hartley showed that organic substances which are perfectly transparent to ordinary light have very definite absorption regions or bands in the ultra-violet, and that their absorption is, in many instances, so characteristic that it constitutes an accurate method of identification. To a considerable extent, this fact is of value when using ultra-violet in microscopy. Objects that show little or no structure by transmitted light are seen to be highly organised when examined by ultra-violet radiations, and the structure seen is in part dependent on the wave-length of the light used. Objects for examination by this method must be dealt with in the living state, or at least in such a manner that no change takes place in their constitution. It follows that none of the ordinary methods of mounting such things as micro-organisms, in which staining, hardening, fixing, drying, or heating is resorted to, can be employed. The method is, in fact, its own staining process, differentiation of structure depending on the difference of absorption in ultra-violet, and not on complex staining processes, which are in some cases causing appearances not associated with the organism itself. Further, apart from the alteration that may take place in the tissues themselves as the result of such processes, their employment in the method under consideration would render them opaque to the radiations used, and, therefore, useless for the purpose. The organisms or tissues are simply mounted in any suitable fluid, such as water, normal saline, Ringer's solution, etc., which is transparent to ultra-violet light and the photograph is taken at once. The result is an image that, whether it shows more or less than a stained preparation, is a representation of the object in the living state, and with greater resolution than can be obtained in the microscope by any other process.

Such a method is obviously one to be tried to its utmost whatever practical difficulties may be involved, and there is little doubt that in time it will be recognised as what it really is—the only great advance in microscopic technique for a generation. The apparatus as used by the present writer is in its essentials the same as that devised by Dr. Kohler (Fig. 1), although in many points of detail improvements have been devised. The quartz objectives are three in number, their equivalent focal lengths being 6 mm., 2·5 mm., and 1·7 mm., their effective numerical aperture being respectively 2·50, 1·7, and 0·7. It will at once be appreciated that in cases where the full aperture can be utilised the two higher powers are of much greater N.A. when used with light of 275 $\mu\mu$ wave-length than any objective available for use with ordinary light. These two are glycerine immersion combinations, the refractive index of the immersion fluid being 1·447. As these systems are not homogeneous, the cover glasses are optically worked fused quartz of uniform thickness.

The slides are also of fused quartz, fitted into a carrier of a special type, which ensures that the surface of the slide is a constant distance from the objective, a point that in practice is of considerable importance. The quartz oculars are five in number, and range from an initial magnification of 5 to 20, giving camera magnifications of from 200 to 3600 diameters. The latter is a good deal too high for satisfactory results with most objects—in fact, it is doubtful, on theoretical grounds, whether such a magnification is justified. The quartz sub-stage condenser

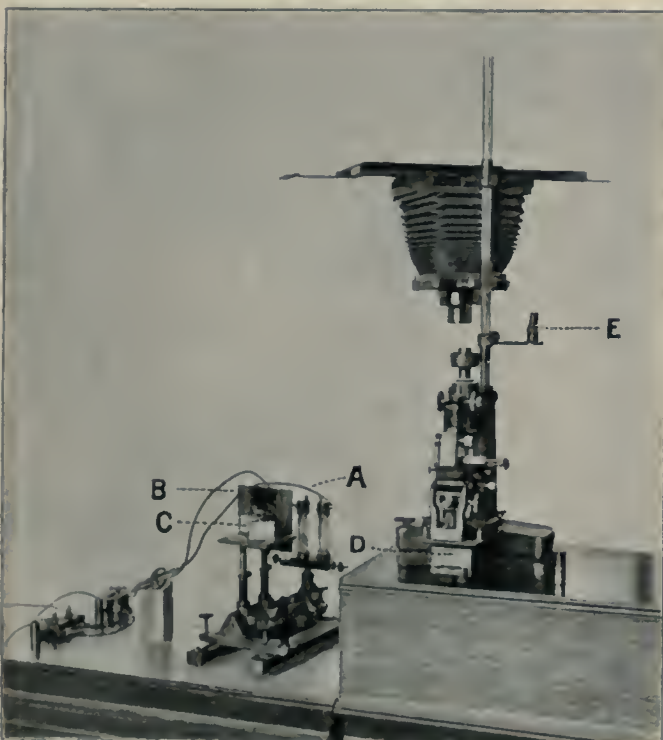


FIG. 1.—A, spark gap; B, quartz condensing lens; C, quartz prisms; D, box containing reflecting quartz prism; E, fluorescent ocular. The position of the other parts described will be evident to any microscopist.

is made with a duplex top, so that a combination is available for each objective to ensure that a suitable cone of illumination is used in each case. This is used as a glycerine immersion system with the two higher-power objectives, and as a dry system with the lowest one.

The source of light is produced by a high-tension discharge in air between metal electrodes, usually cadmium or magnesium, although other metals may be used if they produce a suitable line spectrum. There are obvious limitations in this respect, as the character of the spectrum emitted must be such that the principal lines in the ultra-violet region are sufficiently separated and of considerable intrinsic brilliancy. The spectrum of iron, for instance, is excluded, as, although it is rich in bright lines, these are so numerous and therefore so close together that the isolation of one line is impossible under the conditions realised in this method.

The spark is produced by means of an induction coil of special design giving a heavy discharge of relatively low potential, the equivalent spark-gap being about 5 cm. This is further reduced by placing a condenser immersed in oil in parallel with the spark-gap. The interrupter may be either an electrolytic one or a mercury break, the latter appearing to be more satisfactory. Special arrangements are made for accurately adjusting both the length of the spark and its position in relation to the optic axis of the microscope. The image of the spark is projected by means of a quartz lens, so that, after passing through a pair of quartz prisms of opposite rotation, an image of the spark in one wave-length is obtained approximately at the position of the iris diaphragm below the sub-stage condenser. To facilitate adjustment, a disc of uranium glass is placed at the latter position so that an image of the spark can be observed and focussed as required, after which the uranium glass in its carrier is swung aside. The direction of the illuminating beam is at right angles to the optic axis of the microscope; it has, therefore, to be reflected by a right-angled quartz prism along the axis in the same way that the mirror operates in an ordinary microscope.

The preparation being placed on the stage, the light adjusted, and the condenser accurately focussed on the object, the actual focussing of the image has to be carried out. This is effected by means of a fluorescent searcher eye-piece which is mounted above the quartz ocular, and by the use of which an image is seen on a fluorescent screen and focussed by means of an auxiliary magnifier. This operation is one of considerable difficulty, and only after long practice can success be assured. Its difficulty varies, too, according to the wave-length used; in some cases the fluorescent image is bright, but in others it is much more difficult to see. Some objects themselves fluoresce, with the result that a sharp visual image cannot be obtained. The method now largely adopted by the writer is to observe the object by monochromatic light as emitted by a quartz mercury vapour lamp. This illuminant has bright lines in the violet, blue, green, and orange regions, and by means of suitable screens any one of these can be transmitted.

The image having been focussed visually in one of these lines, the fine adjustment of the microscope is moved by a predetermined amount so that the image is in focus for any desired wave-length in the ultra-violet. This method is quite practicable provided that the fine adjustment of the microscope is of sufficient accuracy (the searcher eye-piece is not used in this case except to confirm the accuracy of the process). The focussing having been performed, the searcher eye-piece is removed, the camera placed in position, and the exposure made. The image is projected for a certain distance, so that it is in focus at the plane of the plate with a known length of camera. The exposures required are as short as two

FIG. 2.—*Saccharomyces Pastorianus* (yeast). × 1700.
Illuminated by means of concentric dark-ground illuminator.

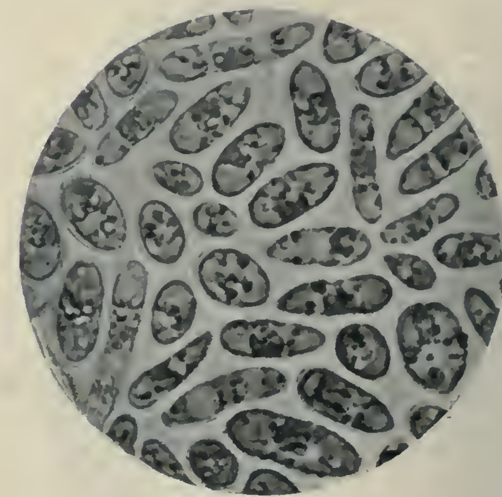


FIG. 3.—*Saccharomyces Pastorianus* (yeast). × 1700.
Illuminated by ultra-violet light.

FIG. 4.—*Bacillus anthracis.* ×1500.
Dark-ground illumination.

FIG. 5.—*Bacillus anthracis.* ×1700.
Ultra-violet light.

seconds under favourable conditions, even at high magnifications.

There was considerable difficulty in obtaining a suitable photographic plate, as one was required of fine grain and with the smallest possible quantity of gelatine on its surface. Gelatine is itself opaque to ultra-violet light, so that the photographic action is confined to the surface of the gelatine, little or no penetration in depth taking place as with ordinary light. The result is that plates must be prepared with the smallest possible quantity of gelatine, but with the maximum quantity of sensitive silver salts that the gelatine can hold together. Such a plate has been prepared by the Kodak Co., and has proved satisfactory. Plates as prepared by Schumann for work in the far ultra-violet have also been experimented with, but for various reasons have not proved so satisfactory. The resulting negatives are at first glance somewhat disappointing if judged by ordinary photographic standards. They are always thin and lacking in violent contrasts, owing to the superficial action of the light, but the detail and fineness of lines due to the shorter wave-lengths used are evident to anyone having any knowledge of photomicrography. Whether the utmost resolution that theory demands can be achieved is at present unproved, not because the method has failed, but because of the difficulty of finding an object that can be regarded as a satisfactory test.

The accompanying illustrations give some idea of the comparative results obtained with living organisms. Figs. 2 and 4 are illuminated by a concentric dark-ground illuminator, the most satisfactory method available for observing living organisms by ordinary light, and Figs. 3 and 5 by a solid cone of ultra-violet light. The apparatus as figured is now in operation in the microscopical department at the National Institute for Medical Research.

Industrial Research Associations.

II.—British Non-Ferrous Metals Research Association.

By Ernest A. Smith.

The Research Association for the non-ferrous metals industry had its inception during the recent conflict, when manufacturers, under the stern necessity of war demands, began to realise the need for fuller knowledge respecting the metals and alloys with which they had to deal. Preliminary meetings were held at the end of 1918 and during 1919, the attendance being well representative of the non-ferrous metals and allied industries, and included smelters, founders, metal rollers, tube manufacturers, wire drawers, and makers of every class of industrial alloys, including the precious metals. After some unforeseen delay the association was formally incorporated in January, 1920, with headquarters in Birmingham, the centre of the British non-ferrous metals industry.

The association seeks the membership not only of firms engaged solely in the non-ferrous metals industries, but also of firms which are substantial users or workers of non-ferrous metals and alloys, such as engineers, shipbuilders, railway companies, etc. It will be obvious that if there is to be effective development of research in this important national industry, the whole-hearted co-operation of every manufacturer and user of non-ferrous metals is essential.

Whilst the main object of the association is to carry on research, it also seeks to disseminate technical and scientific information relative to the production, treatment, manufacture, and uses of the non-ferrous metals and alloys. To this end a bureau of information has been started, thus supplying a long-felt need experienced by many manufacturers in this industry. Attempts are being made to make the bureau as comprehensive as possible, and already good work has been done.

With regard to the scientific aspects of the research work to be undertaken, no definite programme of research has yet been arranged, owing to the comparatively recent date of incorporation, but the council is dealing fully with the matter in the near future. Technical committees, representative of the various sections of the non-ferrous industry, have been appointed to review the field of research in each particular sphere and to report to a full council in due course.

It may be well, however, to indicate briefly in which directions intensive research appears to be most necessary for the future development of the industry. It is now generally recognised that, important and necessary as improvements in smelting and other processes of metal production undoubtedly are, the most marked technical advance in the immediate future may be expected from a more complete study of the properties of metals and alloys, as influenced by thermal or mechanical treatment, and by the presence of foreign matter. This being so, the first duty of the association will be to initiate researches into the fundamental principles which underlie the working of metals and alloys. Whilst it is true that the past few decades have seen considerable progress in non-ferrous metallurgical research, a careful review of this work reveals the fact that existing knowledge respecting non-ferrous metals and alloys is far less exact and complete than that which is available in the case of iron and steel. This lack of more extensive knowledge was brought home to manufacturers by the claims made upon the industry during the war period, and has helped to emphasise the importance of systematic research to provide that new knowledge without which an industry cannot make progress.

More exact data are required in connection with the physical constants of most of the industrial metals, and the vexed problem of the cause of hardening under mechanical treatment still requires elucidation; also problems concerning the quality of hardness and methods of testing such.

Apart from the conduct of research into the constitution and properties of metals and alloys, the most pressing problems that await solution appear to be those connected with the melting, casting, and working of metals in works practice. Each stage of manufacture, from the raw material to the finished product, presents its own individual problems. Realising the importance of starting with a sound ingot, the Brass and Copper Tube Association, in co-operation with the Research Department, initiated in 1918 a research into the production of sound brass and copper castings, under the direction of Prof. Thos. Turner. This research, which was established in a temporary laboratory in Birmingham, has now been handed over to the British Non-Ferrous Metals Research Association. As the result of two years' work, results of practical value have been obtained, and a report will be issued to members shortly. Attention has been directed mainly to the important question of the inclusion of gases, a subject which has been brought more into prominence since the introduction of gas and oil melting furnaces.

The laboratory experiments have been repeated on a commercial scale, with the aid of an electric crucible furnace, which proved to be the most satisfactory method of melting for investigation purposes.

The growing importance of aluminium as a commercial metal has led to the formation of a committee, on which the association is represented, to deal with the corrosion of aluminium and its alloys, and research will be started shortly.

The atmospheric corrosion of non-ferrous metals is also receiving attention, the association having recently taken over this research, which was initiated by the Institute of Metals as one of the researches into the general question of corrosion of non-ferrous metals and alloys. The prominence now being given to aluminium alloys for aero-engines and motor-car construction opens up a wide field for research to gain more exact knowledge on alloys now in use and the introduction of new alloys. Particularly do the problems of ageing and disintegration need further research. The modern requirements of engineering practice call for more extensive information on the non-ferrous industrial alloys which are now produced in such large quantities. Modern research has considerably extended our knowledge of the constitution of the brasses and bronzes, but there is still scope for research into the factors which govern the machining and engineering properties of these alloys. More complete investigation is necessary into the composition of engineering alloys to withstand comparatively high temperatures, and chemical engineers are diligently seeking for non-ferrous alloys that will resist the action of acid solutions and vapours.

In this connection the use of chromium as a constituent metal appears to offer a promising field of investigation; its addition to nickel has produced some valuable industrial alloys, especially for electrical and for acid resistance purposes. but research in this direction is by no means exhausted.

The class of white alloys, including bearing metals and type metals, has so far received little attention at the hands of scientific investigators. Little is known respecting the exact constitution of the various series of alloys of which bearing and type metals are usually composed. There seems to be little doubt that a thorough investigation of this important class of alloys would result in many compositions now in use being discarded. The whole subject of bearing metals requires investigation in the light of modern scientific knowledge, as much information, based on practice, is contradictory.

Rapid advances in steel metallurgy have been made in recent years by the introduction of new alloys of remarkable properties, many of which include in their composition non-ferrous metals such as chromium, vanadium, molybdenum, titanium, tungsten, etc., which only a few years ago were regarded as rare metals. The success which has attended the use of these rarer metals in steel should stimulate investigation with a view to their wider use in the non-ferrous industry. At present practically nothing is known of the influence of these metals on the industrial non-ferrous alloys, with the exception, perhaps, of a few special alloys known as high-tenacity brasses and bronzes, which are very varied in composition and complex in character.

Research is also necessary in connection with the industrial alloys of the precious metals. Little work has yet been done on the mechanical properties of the various gold alloys of 9-carat standard, which constitute 50 per cent. of the jewelry manufactured at the present time. Further work is also required in connection with standard silver, especially on the exact cause and prevention of so-called fire-marks. Alloys to act as satisfactory substitutes for platinum are also required.

Such, in brief, are some of the problems that confront the non-ferrous metal industry, and will doubtless claim the early attention of its particular research association.

Research in connection with metal extraction processes will not, however, be neglected. The association is taking over the work of the Copper and Zinc Inquiry Committee which was especially appointed by the Research Department to review the field of research in relation to the production of these two important industrial metals. Other committees will doubtless be formed to deal with research in relation to the extraction processes of other non-ferrous metals of industrial importance.

The council of the association fully realises that the value of research work is often lost to the manufacturers because of its want of application; in the conduct of its research, therefore, every effort will be made to carry on the work in such a way as to enable the full value of its research investigations to be infused into works practice.

Another important matter which is claiming the attention of the association is the standardisation of non-ferrous alloys, a question which has been brought into some considerable prominence as the result of war conditions, and presents great possibilities of considerable import to the industry.

For the present the research work of the association will be carried out in the metallurgical laboratories of existing institutions and in the temporary laboratory of the association established at Birmingham. It is hoped, however, that when funds become available, permanent premises will be equipped for experimental work and research, and for the bureau and administrative purposes.

Each research decided upon by the council will probably be placed in charge of an expert in the particular subject chosen for investigation, whilst the general supervision of all the researches will be undertaken by the technical officer of the association, as required by the articles. This course appears to be the most satisfactory in view of the diversity of non-ferrous processes, metals, and alloys that require investigation.

Notes.

The King has been pleased to approve of the following awards this year by the president and council of the Royal Society:—A Royal medal to Mr. W. Bateson, for his contributions to biological science, especially his studies in genetics; and a Royal medal to Prof. G. H. Hardy, for his researches in pure mathematics, particularly in the analytic theory of numbers and allied subjects. The following awards have also been made by the president and council:—The Copley medal to Mr. H. T. Brown, for his work on the chemistry of carbohydrates, on the assimilation of atmospheric carbon dioxide by leaves, and on gaseous diffusion through small apertures; the Rumford medal to Lord Rayleigh, for researches into the properties of gases at high vacua; the Davy medal to Mr. C. T. Heycock, for his work in physical chemistry, especially on the composition and constitution of alloys; the Darwin medal to Prof. R. H. Biffen, for his work on scientific principles applied to the breeding of plants; and the Hughes medal to Prof. O. W. Richardson, for his work in experimental physics, especially thermionics.

Dr. H. Deslandres, president of the Paris Academy of Sciences, gave, at the meeting on October 4, an eloquent *éloge* on Sir Norman Lockyer, who was a correspondant of the Academy in the section of astronomy. He referred to Sir Norman as one of the founders of physical astronomy who approached science along untrodden paths and with whose name great discoveries are associated. Among the researches and conclusions to which Dr. Deslandres directed particular attention were those of the observation of solar prominences in broad daylight, the discovery of helium, the effect of variation of pressure on the width of hydrogen lines in prominences, the application of the Doppler-Fizeau principle to the spectroscopic determination of velocities in prominences, dissociation of chemical elements, the temperature relations of long, short, and enhanced lines in spectra, the correlation between solar and terrestrial meteorology, and stellar classification on an ascending as well as on a descending temperature scale as described in "The Meteoritic Hypothesis" and "Inorganic Evolution." Reference was also made to the Hill Observatory, Sidmouth, as "already one of the best provided in England," and Dr. Deslandres concluded his appreciative address with the words: "Dans son ensemble, l'œuvre est considérable et touche aux plus hautes questions de la Science. Sir Norman Lockyer est assurément un des plus grands savants de l'Angleterre, et un des plus grands astronomes de tous les temps. L'Académie s'honore de l'avoir compté parmi ses membres; elle adresse à sa veuve et à ses enfants ses plus vives condoléances."

A meeting of the International Commission for Weather Telegraphy, which was appointed by the International Meteorological Conference at Paris in October, 1919, will be held at the Air Ministry during the week November 22–27. The following delegates are expected to attend the meeting:—Lt.-Col. E. Gold (president), Meteorological Office, Air Ministry; M. A. Angot, Bureau Central Météorologique, Paris; Col. L. F. Blandy, Controller of Communications, Air Ministry; Dr. van Bemmelen, Meteorological Observatory, Batavia; Col. Delcambre, Service Météorologique Militaire, Paris; Prof. F. Eredia, Ufficio Central di Meteorologia, Rome; Prof. E. van Everdingen, Meteorologisch Instituut, De Bilt, Holland; Gen. Ferrié, Ministère de la Guerre, Paris; Capt. Franck, Service de la Navigation Aérienne, Paris; Señor José Galbis, Servicio Meteorologico Español, Madrid; Lieut. H. D. Grant, Meteorological Office, Air Ministry; Dr. Hesselberg, Meteorologiske Institut, Christiania; Col. Matteuzzi, Servizio Aerologico, Rome; Prof. A. de Quervain, Central Meteorological Office, Zurich; M. Rey, Ministère de l'Agriculture, Paris; Capt. C. Ryder, Meteorologische Institut, Copenhagen; Mr. T. Thorkelsson, Meteorological Service, Reykjavik; and Dr. A. Wallén, Meteorologiske Hydrografiske Anstalt, Stockholm. Since the war much progress has been made in different countries in the development of codes for telegraphic reports of the meteorological information which experience in the war and the needs of aerial navigation indicated as necessary. The main object of the Commission is to co-ordinate these developments in the revision and extension of the codes prepared at the last meeting of the Commission, which was held in London in September, 1912.

The Nobel prize for physics for 1920 has been awarded to Dr. C. E. Guillaume, director of the International Bureau of Weights and Measures at Sèvres. The prize for 1919 has been reserved.

The Chadwick Trustees announce that a public lecture will be given by Prof. J. B. Farmer, entitled "Some Biological Aspects of Disease," on Thursday, November 25, at 5.15 p.m. The lecture will be delivered in the lecture hall of the Medical Society of London, 11 Chandos Street, W.1.

The Woburn Fruit Farm, which was carried on from 1894 to 1918 by the Duke of Bedford, and since then by means of a grant from the Development Fund administered by the Committee of the Rothamsted Experimental Station, is to be closed at Christmas owing to the continued ill-health of Mr. Spencer U. Pickering, which renders him unable to continue his experimental work there.

The gold medal of the Institution of Mining and Metallurgy, the highest distinction in the power of the council to bestow, has been awarded to Sir Thomas Kirke Rose "in recognition of his eminent services in the advancement of metallurgical science, with special reference to the metallurgy of gold." The Consolidated Gold Fields of South Africa, Ltd., gold medal and premium of forty guineas have been awarded to Mr. H. Livingstone Sulman for his paper entitled "A Contribution to the Study of Flotation" (Transactions, vol. xxix., 1919–20).

At the anniversary meeting of the Mineralogical Society held on November 9 the following officers and members of council were elected:—*President:* Sir William P. Beale, Bart. *Vice-Presidents:* Prof. H. L. Bowman and Mr. A. Hutchinson. *Treasurer:* Dr. J. W. Evans. *General Secretary:* Dr. G. T. Prior. *Foreign Secretary:* Prof. W. W. Watts. *Editor of the Journal:* Mr. L. J. Spencer. *Ordinary Members of Council:* Dr. A. Holmes, Miss M. W. Porter, Mr. R. H. Rastall, Sir J. J. H. Teall, Mr. A. F. Hallimond, Dr. F. H. Hatch, Mr. J. A. Howe, Lt.-Col. W. Campbell Smith, Mr. T. V. Barker, Prof. C. G. Cullis, Mr. W. A. Richardson, and Dr. A. Scott.

MR. J. HARGREAVES presided over the annual meeting of the Chaldæan Society held at the Great Northern Hotel on November 13. Reports of astronomical work and progress were received from the local sections established at Luton and Tottenham, and the formation of new sections for Warwickshire and Hertfordshire was announced. Special attention was directed to the encouraging work of the society in the observation of the zodiacal light, variable stars, sun-spots, the moon, and photographic work. The secretary, Mr. S. S. Clerk-Maxwell, King's College, Cambridge, expressed a hope for further development and for the formation of local sections south of the Thames. *The Chaldaean* is now published for the society by Messrs. Geo. Philip and Son, Ltd., 32 Fleet Street, E.C.4.

A JOINT meeting of the Physical and Optical Societies for the discussion of "The Making of Reflecting Surfaces" will be held on Friday, November 26, at 7 p.m., at the Imperial College of Science and Technology, South Kensington, S.W.7. The programme will be divided into two parts: (*a*) Technical methods and processes, and (*b*) properties of reflecting surfaces (reflecting powers, etc.). Some demonstrations of actual processes will also be given. Mr. R. Kanthack is making a complete bibliography and *résumé* of previously published work on this subject, and will contribute a description of the results of his investigation to the discussion. Papers have been promised by representatives from manufacturing firms, astronomical observatories, and other scientific institutions. A complete programme will be issued during the week. Tickets may be obtained from the secretary of the Physical Society (Imperial College of Science) or of the Optical Society (39 Victoria Street, Westminster, S.W.1).

REPLYING to a question in the House of Commons on November 15, Mr. Lloyd George said: "The whole subject of chemical warfare has been under careful consideration by the Cabinet during the past year. It was decided on March 4 that the question should be raised at the Council of the League of Nations. It is, I am sure, obvious to the House that this is a question on which our action must depend on that of other nations. It was realised, therefore, that, as other countries have been continuing to develop this method of warfare, the safety of our fighting Services would be seriously jeopardised by lack of similar development in this country, and it was decided on May 12 that, pending a pronouncement on the subject by the League, the fighting Services should continue their researches and experiments. The War Office Committee has been constituted as part of the organisation necessary for the continuation of these studies. The whole subject will, of course, have to be reconsidered when the Council of the League of Nations has made its pronouncement."

REPRESENTATIVES of countries included in the League of Nations and of America met in Paris on October 17–21 for the purpose of forming an International Union against Tuberculosis, which would continue the work carried on by the old international association, the last conference of which was held in October, 1913, at Berlin. Great Britain's representatives were Sir Robert Philip, of the National Association for the Prevention of Tuberculosis and the Ministry of Pensions; Dr. Nathan Raw, also from the National Association; and Dr. Halliday Sutherland, of the Ministry of Pensions. The conference was presided over by M. Léon Bourgeois, and the principal subject raised was the necessity for the early diagnosis of tuberculosis and the methods which could be used for this purpose. The headquarters of the International Union against Tuberculosis will be at Geneva, and the next conference will be held in London in 1921.

MR. E. W. SHANN referred in his letter in NATURE of November 11 to the statement in the leading article in our issue of October 28 that there was "little or no evidence" that the museums of our public schools "are used in school teaching." This statement was based not only on the Report of the British Association Committee, but also on the confessions of public-school science masters in annual conference in 1916, and on personal inquiries from boys and masters while the article was being written. Oundle is a marked exception to the prevailing apathy, yet Mr. Shann in his long and interesting letter devotes only ten lines to the use of the museum in class-work. Such small evidence as there is, in addition to that from Oundle, comes, as in Mr. Shann's case, from the biological and geological sides. This is not because the subject or the material is more suited to the museum method, but because the teachers have had a scientific training and have some appreciation of a museum's usefulness. More might be done even here, but it is in the teaching of history, ancient and modern, and in the elucidation of ancient or foreign authors, that so much more use might be made of school museums.

IN a brochure entitled "A Proposal to Increase the Purchasing Power of the Penny" Mr. Harry Allcock puts forward the view that the value of the penny as 1/240th of the pound sterling has proved too low for post-war requirements, and that, in consequence, penny prices have been advanced by 50 per cent. in many cases where a smaller increase would have satisfied the seller had a single coin been available intermediate in value between 1*d.* and 1½*d.* As a result, two coins are now needed in millions of daily transactions where formerly only one was used, and this has led to a shortage of copper coins and much inconvenience to the public. The provision of either additional copper coins or new nickel coins would involve national expenditure, to obviate which Mr. Allcock suggests that the Government should now increase the token value of the penny by 20 per cent., thus making it represent one-tenth instead of one-twelfth of the shilling and increasing its purchasing power proportionately. The present value of the pound sterling and of all existing notes and silver coins relative to the pound would be unchanged, but the shilling would be divided into ten pence. The consequent loss to the Mint when the copper coins already in circulation became so worn as to need withdrawal would be insignificant, and the risk of the public hoarding copper coins in anticipation of the change could be avoided by imposing this without notice; while holders of large stocks of copper coins for business purposes might be called upon to surrender to the State the amount by which their holdings were increased in value.

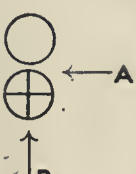
THERE can be no doubt that scientific progress in relation to agriculture has been seriously hampered in the past by the poor material prospects offered to the scientific worker, and the Ministry of Agriculture, in recognising the fact and in attempting to remove the defect, has shown a spirit of enlightened goodwill which is of hopeful augury. The provision of a grant earmarked to cover the salaries of workers in universities and in institutions such as the Rothamsted Experimental Station, in addition to, and separate from, a grant for laboratory and general research expenses, is a real effort to ensure that the workers shall have some security of tenure and some prospect of a settled career in the prosecution of research. The principle is sound, but the practical application is as yet not entirely successful. A system of grading the workers is perhaps inevitable, and the salaries allotted to the different grades are in some respects not unreasonable. But the annual increments are too small, especially during the years when the average worker is marrying and his expenses are increasing, and there is not sufficient range between the extremes of the scale, *e.g.* a worker recently graduated and beginning his career receives 450*l.*; the same man ten years later, with a wife, two or more children, and a position to maintain, receives only twice that amount, and is actually worse off than before. The total number of graded posts is much too small even to cover only those already working in agricultural research. That will, no doubt, be improved as time goes on, but meanwhile it leads to stagnant promotion and invidious selection. There must be something seriously at fault when (to take only one particular instance) a worker of more than thirteen years' experience in research, of acknowledged eminence and authority in an important subject, should be offered, and have in the meantime to accept, a post in the third grade (called "junior assistants"), and be classed along with those at the start of their career with no record of solid achievement behind them.

THE authorities of the New York Zoological Society are justly proud of the fact that a chimpanzee was born in the Gardens of the society on July 14. A very welcome account of this event is given in the Zoological Bulletin of the society for September (vol. xxiii., No. 5) by Mr. W. Reid Blair. The mother of this infant is about ten years old, and was taken in West Africa; the father is about eight years old, and was taken in what was German East Africa. The offspring of these two animals at birth weighed about 3 lb., and measured 16 in. in length. The body was but sparsely clothed with hair, save on the head, back, and arms. In its less prognathous jaws and in the great relative size and form of the ears it differs conspicuously from the adult chimpanzee. Unfortunately, the mother was unable to nurse it properly, so that it lived but a few days. During this time, however, some interesting observations were made upon the behaviour of the mother in regard to her treatment of her infant. Only once before has the chimpanzee bred in confinement. This was in Cuba in 1915.

IN Report No. 9 of the Industrial Fatigue Research Board Mr. P. M. Elton describes his investigations on output in the weaving-sheds of two silk mills. The observations lasted for a continuous period of fifteen weeks, and represent the output of forty-seven experienced weavers. At each mill it was found that the output steadily improved during the course of the experimental period. This was due mainly to the diminishing need of artificial light. In the latter half of February and the first week of March, when no artificial lighting whatever was necessary, the output during the first and last hours of the working day was 11 per cent. greater than at the same hours in January, when lighting was required, though the output in the middle hours of the day (when no artificial light was required in either instance) was practically the same. It might be thought that such a result argued inadequacy of the artificial lighting, but photometric measurements showed that the light was quite good. Another factor which influenced output was the temperature of the weaving-sheds. It was found that a rise of temperature from 59° F. to 65° F. caused a 10 per cent. improvement in output, but no definite relationship between output and humidity could be traced. The practical importance of Mr. Elton's investigations needs no comment. It is only by careful and accurate observations such as he has described that the conditions necessary for maximum efficiency can be ascertained.

IN Memoir No. 6 of the Entomological Series of the Agricultural Department of India, Ramachandra Rao gives a lengthy report of an inquiry into the efficiency of indigenous insect pests as a check on the spread of Lantana in India. This plant is a noxious weed in most parts of India and Burma; various other plants which have been introduced for ornamental purposes have also got, or are getting, out of hand, and are likely to prove sources of future trouble. A native of South and Central America, it has been introduced by man into many tropical countries, and in all suitable localities it is a scourge, displacing the native vegetation and often seriously interfering with the natural regeneration in forests. In the Hawaiian islands an Agromyzid fly introduced from Mexico, the larvæ of which live in the fruits of Lantana, has proved a valuable check, though it has not by any means exterminated the plant. In work of this nature it has to be considered whether the introduced species is likely to turn to plants of economic value and thus do more harm than good. It is necessary, therefore, to make quite sure of this vital point before introducing the Agromyzid into India. The author of this memoir has brought to light a number of insects attacking Lantana in India. The most efficient of these appears to be a small plume moth (*Platyptilia pusillidactyla*), the caterpillar of which feeds on the flower-heads and considerably reduces the number of seeds produced. Its efficiency, however, would be much greater were it not so subject to the attacks of Hymenopterous parasites. No insect is likely to do more than act as a check upon the reproductive capacity of the plant, and until such insects can be satisfactorily brought into operation, the eradication of the plant in (at present) lightly infested districts by cultural methods seems to be the only feasible course.

RECENT investigation into the irregularities of the heart illustrates the great value of researches which apparently have no practical application. The electrical phenomena of muscle and nerve were thought to be of merely academic interest, but after the perfection of the Einthoven galvanometer these electrical reactions became of great use in the study of the action of the heart. By placing pairs of electrodes on the surface of a muscle, as shown by the two circles of the accompanying diagram, it is found that a wave of excitation travelling in the direction of arrow A will reach both electrodes at the same time and the electrical response will be insignificant, but a wave of excitation travelling in the direction of arrow B will reach the electrode, marked with a cross, first, so that an appreciable electrical response will result, and the direction of the electrical current will indicate the direction in which the wave is travelling; the commencement of the electrical response shows the time at which the wave of excitation reaches the electrode. By this method Dr. T. Lewis and his co-workers have followed the path of the excitation in the disorder known as auricular fibrillation (see *Heart*, August, 1920, vol. vii., No. 4). The normal heart-beat starts at a locality known as the sino-auricular node, and spreads in all directions over the auricle. When the wave of excitation reaches the extremities of the auricle it cannot pass back because it is dammed by the refractory period of the contracting auricle. In auricular flutter the wave of excitation passes down one side and up the other, so that it reaches the starting point after the muscle has relaxed. Thus the wave can follow in the same direction and a "circus" movement becomes established. The result is that the auricle beats at a rate of more than 300 contractions per minute. It is not known why the auricle allows the wave of excitation to pass in one direction only, but once it is started it continues because the auricular muscle relaxes just before the wave of excitation reaches it, and the wave of excitation does not catch up to the refractory period of the contracting muscle.



DR. J. RUNNSTRÖM, of the Zootomical Institute, Stockholm, has long been occupied with experiments on Echinoderm larvæ. Among others, he has cut away portions of the larvæ and observed the further development either in those portions or in the individuals from which they have been removed. In *Bergens Museums Aarbok*, 1917–18 (1920), he tells us how he has removed from the larva of a sea-urchin (*Parechinus miliaris*) the sunken area that would in the normal course of metamorphosis produce the young urchin. This did not prevent the formation of a new sinking or infolded sac of similar character, though, owing to the regeneration of the hydrocœl (whence the characteristic water-vascular system develops), the formation of an actual echinoid did not proceed. Even a fragment removed from the same side (the left) of the larva displayed a like infolding, so that a single larva might thus be induced to form three sacs. These results show that in this case the laying down of an organ does not, as Driesch has supposed, limit the faculty of the remaining cells to form a corresponding organ, or perhaps one should say "of the neighbouring cells," for fragments removed from the right side of the larva produce, not an echinoid sac, but an infolding that seems to represent the formation of a new larval gut. In larvæ from which the echinoid rudiment has been removed further deviations from the normal process occur and resemble changes observed in some abnormal holothurian larvæ—an observation of much theoretical importance.

IN recent years dried blood has appeared frequently on the market as an animal food, and, considering the large quantities of this material which are available daily from the abattoirs of Great Britain and the increasing difficulties of obtaining nitrogenous food for animals, an inquiry was started as to the value and safety of utilising dried blood as a nitrogen-supplying food. Blood collected in small quantities and stored before drying is useful only as a manure, but blood which is dried immediately after collection may be used as animal food. Mr. L. F. Newman, in the *Journal of the Ministry of Agriculture* for June last, contributes the results of some feeding experiments with dried blood. He concludes that the addition of blood to an ordinary farm ration of wheat offals may cause considerable gain in weight compared with the results from a diet of offals only, while the addition of blood to plain maize-meal may give an increase equal to the results obtained from feeding offals only. Another material which has been suggested as animal food is the bracken rhizome, and a paper by Prof. James Hendrick on "Bracken Rhizomes and their Food Value" appears in the Transactions of the Highland and Agricultural Society of Scotland (1919). Prof. Hendrick carried out preliminary feeding experiments which indicated that bracken rhizomes are not rich enough in the more valuable food constituents to be of much use for anything but maintenance purposes, and even here their usefulness is limited because they are not palatable to certain classes of stock. During the last forty or fifty years, however, considerable damage has been caused by the spreading of bracken on good pasture lands, and it is possible that by utilising the rhizomes for animal food the infested areas can be cleared without incurring much loss.

THE October issue of the Journal of the American Chemical Society contains a long paper by Mr. W. D. Harkins on the structure of atoms. Evidence is given for the statement that atoms in which the ratio of negative to positive electrons in the nucleus is high are rare, both in meteorites and on the earth. Suggested constitutions are assigned to the nuclei of the more abundant light atoms. The constituents of atoms are regarded as α-particles, positive electrons (hydrogen nuclei), electrons, particles of mass 3 (ν-particles), and secondary structures of positive and negative electrons (μ-particles).

Engineering for November 5 contains an illustrated account of a large depôt to be used for the storage of wool, now approaching completion at Hull. This building is being constructed for the Ministry of Munitions by Messrs. Nissens, Ltd., of Birmingham, and is a development of the well-known Nissen hut, which proved its practical utility on a wide scale so successfully during the war. The area covered is approximately 10 acres, and construction was commenced only on June 16 last. The depôt consists of eighteen buildings of the Nissen type, each 552 ft. long by 40 ft. wide, all communicating. Each semicircular rib is made up of five segments joined by fish-plates; the ribs are held together by wood purlins. The buildings are double-skinned, with an air-space of 7 in. between the inner and outer linings of galvanised corrugated sheet, and are thus damp-proof and not affected by condensation. Only forty men, on piecework, have been employed, and the rate of building has been approximately one bay of 552 ft. completed per week. The form of construction has several advantages, and is suitable for many purposes. Buildings of practically any length can be made; they are absolutely weather-proof, are capable of erection by unskilled labour, and if lined with 2-in. plaster slabs will be found as cool as brick buildings.

Our Astronomical Column.

THE ECLIPSE OF 1922 IN AUSTRALIA.—Further details concerning this eclipse have come to hand. Mr. W. E. Cooke, the Government Astronomer of New South Wales, has visited various points on the Queensland railway within the totality track, and sends a pamphlet containing his experiences. The inhabitants of the villages are willing to give all possible help to observers. The weather prospects are distinctly hopeful, though the altitude of the sun in this region will not be great (26° at most). The most easterly and most accessible station is Stanthorpe, on the Dividing Range, 2656 ft. high, a favourite summer resort, having several good hotels. Those undertaking observations of a delicate nature should go further inland, to Coongoola or Goondiwindi. As there is a branch of the British Astronomical Association in New South Wales, there is reason to hope that all these stations will be occupied. The west coast of Australia in the neighbourhood of Condon or Wallal is favourable as regards height of sun and probability of a clear sky. Mr. H. A. Hunt, the Commonwealth Meteorologist, notes that Wallal, which is a telegraph station, might be reached from Port Hedland, 150 miles to the west-south-west by pearling lugger; a steamer visits Port Hedland about once a month. Mr. Hunt considers the weather prospects much more hopeful here than in Christmas Island. Another possible locality is in Central Australia, near the telegraph station of Charlotte Waters, which is 110 miles from the head of the railway at Codnadatta.

JUPITER'S SATELLITES.—Mr. R. T. A. Innes has carried out a regular series of observations of the eclipses of these satellites, especially of I. and II., since 1908; he gives the main results in Union Obs. Circ. No. 50. On comparing the observed duration of eclipse with the tabular value, there is a regular wave in the residuals with a six-year period, from which it is inferred that the tabular inclination of Jupiter's equator to its orbit needs a positive correction; it is indicated with less certainty that the node of the equator on the orbit needs a negative correction. The tabular values of mean longitude at epoch need the following corrections: I., $-0{\cdot}080°$; II., $-0{\cdot}031°$; and III., $-0{\cdot}006°$. These results are of interest, and they show that the idea, so generally held, that ordinary visual observations of these eclipses are no longer of use, is not correct.

Mr. Innes appeals to all observers to unite in observing the eclipses with special care for the period 1920 December 9 to 1921 May 31. The month February 18 to March 18 may be omitted, as eclipses then take place very near the primary. The disappearance of the last speck of light and the re-appearance of the first speck are the phenomena to which attention should be specially directed. The aperture and condition of seeing should be noted. Mr. Innes points out that observations of satellite I. afford a delicate test of the constancy or otherwise of the earth's rotation.

THE ORIGIN OF SPECTRA.—Dr. H. H. Plaskett contributes an interesting article on spectra to the Journal of the Royal Astronomical Society of Canada (vol. xiv., p. 7). The paper summarises Nicholson's work on the atom and that of Planck and Einstein on the quantum theory of light. It is pointed out that there are some serious difficulties in the quantum theory. "Interference can be obtained with a path-difference of more than a million wave-lengths. This seems to require that the quantum must have this length (several feet) in space. Further, the experimental fact that a 3-ft. O.G. has a higher resolving power than a 3-in. can only be interpreted as meaning that the quantum has a 3-ft. cross-section. It is difficult to see how a quantum of such dimensions is indivisible, and if it is, how any light gets into a 3-in. telescope." It is suggested that the facts seem to require some compromise between the undulatory and quantum theories; in fact, the author considers a satisfactory theory of radiation as the first desideratum of future progress, the second being a solution of the three-body problem as applied to the more complex atoms.

Dr. Silberstein's suggestion that the atomic nucleus may not be a homogeneous sphere of positive electricity, but a collection of point charges, is shown to remove some difficulties, but to create others, which have not yet been solved.

The Bulawayo Meeting of the South African Association.

THE eighteenth annual session of the South African Association for the Advancement of Science was held in Bulawayo, Southern Rhodesia, on July 14–17, with Dr. I. B. Pole Evans as president. There were the usual receptions and functions, together with visits to the Khami ruins, the Matoppos, the Victoria Falls, and Livingstone. A party, after the conclusion of the official meeting, visited the Great Zimbabwe.

More than sixty papers were read in the various Sections, and the attendance was a large one, more than 130 members proceeding by special train from the Transvaal, as well as some from the Cape Peninsula and Natal.

The president, Dr. I. B. Pole Evans, Chief of the Division of Botany and Director of the Botanical Survey of the Union, gave a most interesting address on "The Veld: Its Resources and Dangers," the address being illustrated by a series of beautiful lantern-slides. He reviewed recent progress in botanical knowledge, and outlined the notable advance that had been made by the members of the Botanical Survey in respect to systematic ecology, indigenous grasses, fungi, and poisonous plants. By "veld" is meant the natural vegetation of the country. The botanical regions correspond to a large extent with the geological formations, and nineteen types of veld, each with its own characteristic flora, can be identified. An outline was given of the geographical and geological features, climatic conditions, predominant flora, and plants of economic importance of each region. The grasses, poisonous plants, and those yielding drugs, fibres, oil, rubber, timber, and tanning materials, were noted. The need for co-operation among workers in different fields of research was strongly urged, and was illustrated by reference to the co-operation of botanists and veterinarians in the elucidation of certain stock diseases due to poisonous plants. The need for the closer association of the botanist and chemist for the investigation of various problems in animal nutrition was indicated. In conclusion, the president stated: "The investigation of such questions is of enormous importance from an economic point of view, and when such problems are scientifically and systematically attacked the veld will yield a hundredfold its present resources, and its dangers will correspondingly decrease and diminish."

Mr. H. E. Wood, of the Union Observatory, Johannesburg, as president of Section A, gave an address on "Recent Progress in Astronomy," noting that the present year was the centenary of the foundation of the Royal Observatory at the Cape. A very interesting comparison of the astronomical knowledge of a hundred years ago with that of the present day was given. The problem of the measurement of the distance of the stars by various methods was outlined, and the rapid progress due to the use of the blink microscope described. An account of the helium stars, of the behaviour of the variable stars, and of the important results accruing from the combined investigation of their absolute magnitude and spectroscopic constitution was given.

"Geology in Relation to Mining" was the subject of the presidential address to Section B, given by Mr. F. P. Mennell, who has seen all the later developments in the mining industry of Rhodesia. A detailed account was given of the ways in which the economic geologist could aid countries like the Union of South Africa and Rhodesia by showing that their internal resources were sufficient in kind and amount to form the basis of essential industries without overseas aid. Gold, chromite, coal, zinc, iron, and copper are present, and in the production of chromite Rhodesia leads the world. The structure of the Rhodesian gold-bearing rocks and its influence on the development of such reefs industrially were set forth. In conclusion, it was pointed out that the mining industry led to the manufacture of such products as pipes, wire, and chemicals on the spot, and so to the establishment of local industries.

Dr. T. R. Sim, late Government Forester in Natal, delivered the presidential address to Section C on "Causes Leading towards Progressive Evolution of the Flora of South Africa." He showed that change in the flora was continuously going on, and that there was an interaction between flora and climate. These interactions cause a definite trend, not necessarily in the direction of new species, but in the gradual disappearance of what were climax types. The influence of cultivation, bush-cutting, and climatology on flora was considered, while sun-spot cycles and rainfall cycles were described in considerable detail By the prevention of grass-burning, by forest maintenance, and by increasing the area under exotic trees the amount of moisture retained and reprecipitated could be vastly increased; thereby a more temperate method of rainfall would result, and consequently less erosion of the soil occur.

In Section D the presidential address was delivered by Mr. C. W. Mally, Cape Entomologist, whose subject was "Some Zoological Factors in the Economic Development of South Africa." The need for a zoological survey of the Union was mentioned, and the problem of the blending of white and coloured races was discussed and disapproved. The problem of "big game" was considered. Entomological research in relation to human and animal diseases and to agriculture was outlined, and the insect pests of maize, wheat, and olives were described. Fluctuations in the relative abundance of insects over various periods appeared to be more or less inexplicable. An account was given of some results achieved in combating insect pests of crops by the use of insecticides and natural enemies. A plea for adequately trained men for scientific research in South Africa concluded the address.

The Rev. H. A. Junod, president of Section E, gave a most interesting address on "The Magic Conception of Nature among Bantus." He outlined the peculiar difficulties in connection with the mentality of natives, and showed the necessity for a proper knowledge of their laws and customs by the dominant race. The Bantu mind does not concern itself with causes, but believes that any abnormal phenomena such as drought or disease are produced by spiritual agents who possess the power of witchcraft. Numerous interesting examples of the reasoning by analogy of the Bantu were given, and a demonstration of the native magic practice of "bone-throwing," together with a most interesting explanation of the symbolism, was presented. This ingrained magic conception was the stumbling-block to Bantu progress.

"Labour Conditions in South Africa" was the subject of Prof. R. Lehfeldt's presidential address to Section F. The problem is complicated by the presence of many natives. The sharp barrier between the races leads to the production of the "poor white" class, who become destitute and lazy while clinging to the remains of racial pride. The same condition prevents the more intelligent members of the native races from rising. Rural colonies failed for various reasons, and the great majority of the destitute cannot become independent farmers, but must work for wages. Native labour is cheap, and so forms an obstacle. A policy of segregation of the races in different parts of South Africa is almost impossible economically. The address closed with an aphorism: "A country will, in the end, belong to the people who do its work."

An evening lecture was delivered by Prof. J. A. Wilkinson on "The Nitrogen Problem." The South Africa medal and grant were awarded to Prof. E. Warren.

It is only possible to notice briefly a few of the many papers read before the various Sections, but most of them will be printed in the Journal of the Association.

In Section A, Prof. P. G. Gundry read an interesting paper on the effect of high temperature and the elevation of aerodromes in the taking-off of aeroplanes. Prof. W. N. Roseveare contributed a short note on Einstein's planetary equation. Father Goetz wrote on rainfall and barometric variation in Bulawayo.

Messrs. A. M. Macgregor, H. B. Maufe, and A. J. C. Molyneux contributed papers on the geology of Southern Rhodesia to Section B. Mr. G. N. Blackshaw investigated magnesia-impregnated soils, and concluded that the most economical treatment for them was liberal dressings of kraal manure. Such soils occur in the Great Dyke of Southern Rhodesia. Mr. E. V. Flack has analysed samples of bat guano deposits in Rhodesia. They vary in composition, but often the addition of sulphate of potash or nitrate of soda or superphosphate greatly adds to their value as fertilisers.

Dr. P. van der Bijl contributed a monograph on the Polyporeæ of South Africa to Section C. Prof. D. Thoday described the ericoid leaves of the Maquis of the Cape Peninsula, and Mrs. Thoday gave an account of the seed of *Gnetum gnemon*. Dr. E. Marion Delf discussed the distribution of accessory food-factors in plants, and Dr. T. R. Sim read a paper on South African ferns. Mr. A. O. D. Mogg described an interesting method of veld estimation by counting plants in transects, while Prof. S. Schonland discussed certain Crassulaceæ found in Rhodesia.

Papers on the causation of "lamziekte" were contributed to Section D by Sir Arnold Theiler, and from another point of view by Dr. E. R. Hartig. The former has found that bone-meal satisfies the abnormal craving exhibited by cattle suffering from the disease, and farmers in "lamziekte" areas, such as around Vryburg, are being advised to add bone-meal to the rations of their infected cattle. Dr. Annie Porter described the life-history of the African sheep and cattle fluke, *Fasciola gigantica*, and exhibited specimens. She has proved experimentally that the intermediate host is the snail, *Limnaea natalensis*, in which the young stage, *Cercaria pigmentosa*, occurs. Prof. H. B. Fantham gave an account of his continued observations on various parasitic protozoa found in South Africa. He has shown that there is a seasonal variation in the occurrence of the spores of *Sarcocystis tenella*. Mr. J. Sandground contributed an interesting paper on the economic importance of a study of Nematodes, mentioning his researches on *Heterodera radicicola*. Mr. S. H. Skaife described a Tachinid parasite of the honey-bee.

In Section E, Mr. N. H. Wilson, of the Rhodesian Native Affairs Department, gave a paper on the future of the native races there, and considers that it is necessary to allow both white and black to make full economic use of their abilities with the white man as a directing and predominant partner. The Rev. H. A. Junod, in describing some features in the religion of the Ba-Venda, mentioned that they have two sets of religious institutions, ancestor worship and a vague monotheistic notion. The Rev. W. A. Norton described some of his ethnological and linguistic studies in Bechuanaland.

A paper on agricultural economics by Prof. R. A. Lehfeldt, and one on geographical method by Mr. J. Hutcheon, were contributed to Section F.

Johannesburg is now the seat of the headquarters of the Association, and the next meeting will be held at Durban in July, 1921. H. B. F.

Geography at the British Association.

AFTER the presidential address by Mr. J. Macfarlane the proceedings of Section E began with a paper by Mr. D. Lleufer Thomas on some geographical aspects of the distribution of population on the South Wales coalfield. The main coalfield of South Wales comprises about 780 square miles. It is chiefly an elevated plateau with an average altitude of 1000 ft., rising in North Glamorganshire to some 2000 ft., and is deeply scored by narrow, declivitous valleys. These valleys open by narrow gaps to the coastal plain. The result of these conditions is that the population, which is mainly dependent on the coal outcrops, is pent up in the valleys and somewhat removed from the outer world. Another determining factor in the location of population was the occurrence near the coal of raw materials valuable in manufactures, such as iron, or sites offering special facilities for the assembling and treatment of imported materials, such as Swansea, which attracted the copper of Cornwall. Until nearly the middle of the nineteenth century coal-mining was entirely subsidiary to iron-making, and the development of the coalfield was therefore confined to its outer fringes, leaving the whole of the interior as sparsely populated as in the pastoral age. Development gradually spread southwards from the iron centres down the valleys. The present congestion of population is of comparatively recent date. The population is recruited mainly from the West Midland Counties, especially the British district, and to a less extent from the south-western counties. As a result, Monmouthshire and, to a less degree, East Glamorganshire have been anglicised in speech. In the discussion following the paper Mr. H. J. Randall emphasised the transitory nature of the population referred to and its complete dependence on coal production and demand.

Dr. A. E. Trueman read a paper on the iron industry of South Wales. The distribution of the industry was determined by the working of ironstone nodules, which are richest in the eastern part of the coalfield. Local hæmatitic ores have had little effect on the industry. The ironstone nodules were originally collected in stream-beds and worked chiefly along the northern outcrops, where the dip is less steep than in the south. With the deforestation of the country smelting declined, but revived in the nineteenth century with the use of coal. The phosphatic nature of the nodules rendered them unsuitable for the manufacture of steel by early processes, and the output of local ore gradually decreased. At present it is only a few thousand tons a year, most of which is sent to Staffordshire for smelting. The South Wales iron industry is now dependent on imported ores, chiefly hæmatite from Spain. While it persists in the north-eastern part of the coalfield, where it originated, there is some tendency to move the industry to the coast in order to save transport.

Mr. A. E. L. Hudson directed attention to an interesting scheme initiated by the Welsh Department of the Board of Education for the collection of rural lore by the schools of Wales. The scheme affords at the same time an excellent opportunity for the collection of regional survey material, and so introduces this important aspect of geographical teaching into the school curriculum.

Lt.-Col. W. J. Johnston described the methods employed for the production of small-scale Ordnance Survey maps. The introduction of colour in the one-inch maps in 1894 caused a decreased demand for the engraved form. Printing from copper plates is a slow process, and with the large editions necessitated nowadays is practically out of the question. At the best about 20 copies an hour can be printed in one colour from a copper plate, while a modern rotary machine can produce 2000 copies in the same time. Lithography is therefore superseding copper-plate printing in this and other countries. Col. Johnston discussed at length the various methods and showed numerous specimen sheets. He dwelt on the advantages of drawing on paper and then making direct zinc plates by means of photo-zincography. This is not only the quickest method and allows of rotary printing, but it also admits of fresh fundamental plates being made in a few hours without any risk of the subsidiary plates being out of register. For all practical purposes the glass negative is a permanent record, and has the advantage that corrections in detail can easily be made on it.

Capt. H. Allan Lloyd discussed the essentials of maps for aviators. Speaking from much experience on the Western Front, he considered that in order to be of value aerial maps must incorporate details of the outstanding features of town-planning and the nature and characteristics of the ground as seen from the aerial viewpoint. Opinion was far from unanimous as to the amount of detail necessary, but aviators were agreed that the topographical map made for land travel was not suited for their purposes. Natural and artificial features which attract the eye must be emphasised, and detail which is not distinctive, as well as most of the names, must be omitted. Capt. Lloyd believed that aerial maps should show the distinctive plan of each town exaggerated beyond the scale of the map in order that such prominent landmarks as towns might be recognisable by a fleeting glance through a rift in the clouds. Aerial maps of the future, in order to be widely useful, must meet the needs of the man half-trained or practically untrained in map-reading. Capt. Lloyd proposed also to distinguish between certain types of terrain, each characterised by shapes of fields, density of buildings, or other features, and to indicate these on the map, adding illustrations of the types in the margins.

The Section met jointly with Section L (Education) to hear Prof. W. L. Myres open a discussion on the place of geography in a reformed classical course. Recent decisions regarding "compulsory Greek" compel drastic revision of classical teaching. With the postponement and restriction of language courses the aim must be earlier acquaintance with ancient conduct and thought through a closer co-ordination between history, literature, and geography. The Mediterranean region forms a natural supplement to homeland geography, and is a unity bound together by the sea. A study of Mediterranean geography, with its emphasis on outdoor life, the outcome of its climate, and its dependence on woodland in place of grassland, is invaluable in giving a sense of proportion to the study of the geography of the British Isles. Prof. Myres regretted the lack of a good account of Mediterranean geography in English. The discussion was continued by Sir Robert Blair, Mr. G. G. Chisholm, Mr. H. O. Beckit, and the Rev. W. J. Barton. Mr. Beckit insisted that the study of geography saves history from becoming an abstraction and gives it reality. Mr. Chisholm pointed out the need for correlating history, geography, and literature with the adequate study of economics.

The Rev. W. J. Barton read a paper on the oases and shotts of Southern Tunis, and Dr. E. C. Jee contributed a paper on the movements of the sea to a joint meeting of Sections D and E. Dr. R. N. Rudmose Brown directed attention to the urgent scientific needs of the exploration of the oceans on a large scale with modern equipment and methods. In this connection the Section supported the movement initiated by Section D, urging the Government to undertake an oceanographical expedition at least comparable in scale with that of the *Challenger*.

Prof. E. H. L. Schwarz lectured on the Kalahari and the possibilities of its irrigation. In the 300,000 square miles which comprise the Kalahari Desert there are three great depressions which formerly held water. These are the Ovamboland, Etosha, and Great Ngami depressions. Prof. Schwarz outlined his scheme for a weir on the Kunene, by which the waters of that river could be turned into Ovamboland and restore the country to fertility, the surplus water finding its way to the Etosha. By weiring the Chobe its waters would be prevented from passing to the Zambezi, and could be made to flow to Ngami.

Dr. Vaughan Cornish, in a lecture on Imperial capitals, discussed the positions of the great capitals of ancient and modern times, particularly in reference to strategic considerations. Imperial capitals, as a rule, have not been, and are not, in the centre of their dominions, but in a position between this and the most important frontier. Such a position combines the best site for the administration of domestic affairs, which is the natural crossways of routes nearest to the centre, with the most suitable place for military headquarters and foreign relations, which is towards the principal frontier.

Dr. T. Ashby read a paper on the water-supply of ancient Rome. He dealt mainly with the four important aqueducts, the Anio Vetus and Anio Novus, which drew their supply from the Anio River, and the Aqua Marcia and Aqua Claudia, which made use of springs in the Anio Valley. These still form the most important source of supply for the modern city.

The work of the Section concluded with a paper by Principal E. H. Griffiths and Major E. O. Henrici on the urgent need for the creation within the Empire of a central institution for training and research in the science of surveying, hydrography, and geodesy. The work of such an institution would be to train surveyors by the most modern and exact methods and to turn out men suitable for the various Survey Departments of the Empire; to keep surveyors in touch with the activities and progress in all parts of the world; to give instruction in hydrographic surveying; and to conduct research in problems concerning the tides, terrestrial magnetism, and geophysics generally, particularly in the higher branches.

During the meeting of the Association a collection of maps illustrating various aspects of the geography of South Wales, arranged by the Cardiff branch of the Geographical Association, was exhibited in the reception-room in the City Hall.

National Union of Scientific Workers.

THE annual meeting of the council of the National Union of Scientific Workers was held at King's College on November 13. In his address Dr. J. W. Evans, the retiring president, dealt with the subject of "Research at the Universities." Dr. Evans paid a tribute to the achievements of scientific workers during the war, and pointed out that the task ahead of them was of even greater consequence and allowed of no relaxation of effort. After summarising the activities of the Department of Scientific and Industrial Research, he expressed dissatisfaction with the present attitude of this Department towards the scientific and technical faculties of our universities. Since the publication of its first report the Department appeared to have abandoned the more fruitful policy of encouraging to the utmost the research workers at the universities. The restrictive character of the present grants to individual workers at such institutions tended to divorce research from teaching. In his opinion this was a fundamental error, since the best results in research could be achieved only by those who devoted some time to teaching. Apparently the Department looked to the universities and technical colleges to maintain a supply of competent research workers for the State-aided research associations rather than to undertake industrial research for themselves. He considered that a teaching staff engaged in research work, both in pure science and in its applications to industry, was in a more favourable position to discover and develop new principles than research workers isolated and restricted in the laboratories of research associations or even Government research institutions. In conclusion, Dr. Evans urged the importance of universities including in any course in science some training in research methods. This he embodied in a resolution which was supported by Prof. Soddy, who stated that Prof. Perkin had already applied this principle to the chemistry courses at Oxford University. Chemistry students there had shown by their enthusiasm how much the change was appreciated.

Continuing, Prof. Soddy said that since the president had prepared his address there had been a complication brought about by a request from the War Office that the universities should undertake research into the development to the utmost extent of chemical warfare research for offensive and defensive purposes. He expressed the view that it was a matter that must inevitably be considered, sooner or later, by the union. It ought to be considered before rather than after the occasion arose. He was glad that the executive of the union had already decided to appoint a committee to go into the whole question.

The resolution disapproving of the policy of the Department of Scientific and Industrial Research, in establishing and financing research associations, which hands over to the private use of profit-seeking monopolies valuable knowledge obtained at the expense of the whole community, and places the research associations in a position to exploit the scientific workers of the country for their own benefit, was carried unanimously. Prof. Soddy stated that the Government had capitulated to the big business interests in politics and departed altogether from its original intentions. There was no greater example of unfair competition than in the chemical industries.

Mr. A. A. Griffith, in moving a resolution that for the present Advisory Council of the Department should be substituted a council elected on different principles, pointed out that there could be little effective criticism of the Department under the existing arrangement whereby the Government practically appointed its own critics. It was certain that a council part of which was elected by democratically constituted scientific organisations would result in more careful scrutiny and criticism of the acts of the Department.

A resolution by Mr. F. A. Potts to the effect that scientific workers employed as whole-time officials in Government Departments should enjoy status and pay not less than those enjoyed by the administrative class of Civil Servants was carried unanimously.

Prof. Leonard Bairstow was elected president for the ensuing year.

University College of Swansea.

THE University College of Swansea, which was incorporated in January of this year and made a constituent college of the University of Wales by a new University charter sealed as recently as August 13, opened its first session on October 5. The court of governors of the college held its annual meeting on Monday, November 15, and at the conclusion of the meeting the principal, Dr. T. Franklin Sibly, delivered an inaugural address.

After paying a tribute to the pioneers of the university movement in Wales, the principal recalled the fact that the local initiative and private benefactions which brought the college into being had their mainspring in the demand for scientific teaching and research which should benefit the great industries of the district. But no time was being lost in making provision for a faculty of arts, in willing response to the insistent local demand which arose from the conviction that a one-sided institution could possess no full title to university rank. It was, however, in the domain of science that the college would always discharge a large part of its mission; and Dr. Sibly laid emphasis upon the true humanity of the man of science and the nobility of the scientific ideals of a search for truth and of a disinterested co-operation with other workers.

The college was situated in the industrial heart of Wales. The leaders of local industry, headed by the president of the college, Mr. F. W. Gilbertson, were displaying a unique degree of enlightenment and generosity in their support of the college. To the original endowment fund of some 70,000*l.* they had already added donations amounting to more than 4000*l.* and subscriptions which totalled more than 6000*l.* per annum. The subscriptions, having been promised for a period of five years, were expected to earn an equivalent annual grant from the State. Dr. Sibly believed that the workpeople of the district would prove no less staunch as supporters.

The Municipality of Swansea, which had promoted the college, had already given a magnificent site of forty-five acres in Singleton Park, offered the use of Singleton House, and promised further support. The college set the highest store on all grounds by its close association with the town.

There were, however, some serious material disadvantages. The adverse factors of inflated prices and depreciated currency were all the more serious in view of the relatively heavy cost of staffing and equipping technological departments. The measure of State aid in sight was quite inadequate.

Outlining the range of their activities and the spirit in which they entered upon them, the principal laid stress upon their work in applied science on one hand, and upon the extra-mural field open to them on the other. They possessed the means of building up a great school of metallurgy which would work in the closest co-operation with industries at its very doors. A strong department of mining and fuel technology would be essential to the future development of the college, but the funds needed for its inception were not yet forthcoming. They realised the vital importance of research in these fields as in others. Adult education was one of the greatest problems of the modern universities, and they sought to take the university to the people in the fullest possible measure.

It was a duty and an essential of success to associate themselves as closely as possible with local needs and national aspirations, but they had also to play their part in the world-mission of the universities. They were laying the foundations of a great institution which would exist and work in order to enrich the life of the people.

University and Educational Intelligence.

BIRMINGHAM.—The Huxley lecture is to be delivered in the Mason College on Friday, November 26, by Prof. C. S. Sherrington, who has chosen as his subject "The Gateways of Sense." The lecture is open to all members and friends of the University.

EDINBURGH.—Dr. John Stephenson, until recently professor of zoology in Government College, Lahore, has been appointed lecturer in zoology in the University.

OXFORD.—On November 16 Convocation passed a cordial vote of thanks to Prof. James Mark Baldwin for his offer to pay for the present, in honour of his friend, Prof. Poulton, an annual sum of 100*l.* into a fund to be called "The Edward Bagnall Poulton Fund," to be applied at the discretion of the Hope professor of zoology for the time being in the promotion of the study of evolution, organic and social. Prof. Baldwin has also announced his intention of leaving by will moneys for the sustentation of such a fund.

The nomination by the Council of the Royal Society of Prof. C. S. Sherrington, Waynflete professor of physiology, to the presidency of the society has given great satisfaction throughout the University.

MR. G. S. ROBERTSON has been appointed lecturer on agricultural chemistry in the newly founded department of agriculture of the Queen's University of Belfast.

LORD ATHOLSTAN has given 100,000 dollars (more than 25,000*l.* at the current rate of exchange) to the special fund now being raised by McGill University, Montreal.

THE Toronto correspondent of the *Times*, in illustration of the liberal attitude of the Quebec Government towards education, states that the Legislature will be asked to vote 1,000,000 dollars (approximately 250,000*l.*) to McGill University.

COL. S. L. CUMMINS, who in 1913 succeeded Sir William Leishman as professor of pathology of the Royal Army Medical College, Millbank, has been appointed to the new chair of tuberculosis at the Welsh National Medical School, founded by Major David Davies, M.P.

WE learn from the *Times* that the Government of Burma has decided to establish a university at Rangoon. The administration will be in the hands of a council, with an executive committee, comprising representatives of such bodies as the Burma Chamber of Commerce and the Rangoon Trades Association, while matters connected with teaching will be in charge of a Senate composed almost exclusively of professors and lecturers.

DR. RUSSELL WELLS, Vice-Chancellor of the University, was entertained at a house dinner at the University of London Club on November 10. Lord Moulton, who presided, paid a high tribute to Dr. Wells's work for the University, referring particularly to his success in raising 300,000*l.* for degrees in commerce, mainly from men of business. Work of this kind tended, he said, to break down the isolation which was so frequently the bane of universities. Dr. Wells said that their object was to make the University of London in the educational world what the City of London was in the world of commerce.

THE first Congress of Universities, which was held in London in 1912, was a conspicuous success. All the universities of the Empire, to the number of fifty-three, were represented, in most cases by their executive heads, together with several of their professors. The report of the proceedings, an imposing volume of some 460 pages, is a valuable contribution to the politics of education. The Universities Bureau was an outcome of this congress. To it was entrusted the summoning of future congresses at intervals of five years. The war prevented this intention from being carried into effect, and, since hostilities ceased, the great pressure under which the universities have been working has made it impossible for their representatives to gather from the four corners of the Empire earlier than next summer. It has now been arranged that the second congress shall be held in 1921. Dr. Alex Hill, who organised the first congress and has acted as secretary to the Bureau since its institution, is engaged in its promotion. The number of universities in the Empire has now increased to fifty-eight. It is hoped and anticipated that all will make a point of sending delegates to this great council on higher education. With great generosity the University of Oxford has invited all members of the congress to be its guests on July 5–8. The Chancellor of the University, Lord Curzon, will preside over the morning session on July 5, and Mr. A. J. Balfour, Chancellor of the University of Cambridge, will preside in the afternoon. On the preceding day the congress will assemble in London for certain ceremonial functions and entertainments, of which the programme will be announced at a later date. During the fortnight preceding the meeting of the congress members from overseas will visit the various universities of the United Kingdom in turn, in order that they may become acquainted with their methods and resources.

Societies and Academies.

LONDON.

Royal Society, November 11.—Sir J. J. Thomson, president, in the chair.—Dr. W. G. **Ridewood**: The calcification of the vertebral centra in sharks and rays. In the course of the inquiry 150 sharks and rays, belonging to 68 species and 44 genera, were examined. The investigation largely resolved itself into ascertaining the limits of the three component cartilages of the definitive centrum, namely, the sheath-cartilage, the arch-cartilage, and the perichondrially produced cartilage, and studying the relations of the calcified lamellæ to these parts. Similarity in pattern of the calcified lamellæ is shown in certain cases to be homoplastic, the lamellæ being developed in sheath-cartilage in some genera and in perichondrial cartilage in others. In some cases the similarity may be accounted for by convergent degeneration from ancestral types which there is reason to believe were themselves different in their mode of calcification. The distribution and proportions of the three kinds of cartilage composing the centrum are of greater morphological importance than the disposition of the calcified lamellæ in them, and the difference between chorda-centra and arco-centra is relative rather than absolute. In some cases (Lamnidæ) the centra possess so little sheath-cartilage that they approach the arco-centra of Esox and Amia.—Dr. A. **Compton**: Studies in the mechanism of enzyme action. I.: *Rôle* of the reaction of the medium in fixing the optimum temperature of a ferment.—C. H. **Kellaway**: The effect of certain dietary deficiencies on the suprarenal glands. Changes in the size and adrenalin content of the suprarenal glands of pigeons were found constantly when the diet consisted of polished rice alone, or when an adequate ration of protein or of fat was added to the dietary, and were associated with the appearance of polyneuritis. The daily administration of a sufficient amount of "Marmite" to the diet of polished rice prevented these changes from occurring. An attempt was made to explain the enlargement of the adrenals as being due partly to congestion and œdema of the gland-tissues, and partly to the storage in the cortex of the gland of lipoids set free by the breaking down of body-tissues. The investigation of the cholesterol content of the adrenals of normal and polyneuritic birds did not support this theory of lipoid storage. The increased residual content of adrenalin was attributed to diminished output of adrenalin, as a result of the greatly lowered metabolism in birds fed on deficiency dietaries. The histological appearances of the glands suggested obstruction of the venous outflow from the medulla by cortical hypertropy as an additional cause. Œdema in birds fed on deficient diets was of infrequent occurrence, and could not be produced by the daily administration of large doses of adrenalin. It does not appear to be causally related to an increased output of adrenalin.—E. J. **Collins**: The genetics of sex in *Funaria hygrometrica*. Cultures of *F. hygrometrica* from spores reproduced the normal monœcious plants; vegetative cultures derived from the antheridia and the surrounding "perigonial" leaves of the male "inflorescence" produced male plants only, pointing to the probability that a separation takes place such that the element upon which the monœcious condition depends is dropped out of those cells from which the male organ with its surrounding leaves is formed. Vegetative cultures from the archegonium and the surrounding "perichætial" leaves have been made, and have produced typical monœcious plants. The conclusion is that up to the point of the formation of the female organ the cells of the haploid gametophytic phase retain the power to produce monœcious plants, whereas the leaves surrounding the male organ have lost this power. Sex-segregation here occurs in a haploid tissue.

Geological Society, November 3.—Mr. R. D. Oldham, president, in the chair.—Miss M. E. J. **Chandler**: The Arctic flora of the Cam Valley at Barnwell, Cambridge. The Pleistocene loams and gravels at Barnwell, Cambridge, contain peat-seams showing variations in character which are probably dependent on the ordinary laws of transport by water. These seams have added numerous new plants to the small flora previously known to occur therein, so that the floral list now includes about eighty-nine species. The plants identified were grouped as follows: (1) The Arctic element. (2) The plants of wider distribution. (3) The southern element. (4) The calcareous-soil element. (5) The estuarine element. Attention is directed to the complexity of the flora because of its bearing on the whole question of peat deposits in river-gravels. The Arctic floras of the Lea and Cam Valley differ in the occurrence, to a great extent, of different plants and plant-families in the two cases, and in the more pronounced Arctic character, exotic element, and calcareous-soil element in the Barnwell flora. If the floras lived during different cold periods, their discrepancies could be explained by an appeal to the interval of time which separated them; if, as seems more probable from stratigraphical evidence, they lived during the same cold period and were approximately contemporary, the gradual oncoming or decline of the cold, together with the respective geographical situations in the two cases, would probably be a sufficient explanation of their points of dissimilarity.

Aristotelian Society, November 8.—The Very Rev. W. R. Inge, Dean of St. Paul's, president, in the chair.—W. R. **Inge**: Inaugural presidential address on "Is the Time Series Reversible?" The kinematograph has illustrated the possibility of observing events in a reversed time order; is it possible that we might actually move through time in a reversed order so that effects would be thought of as causes? If the positions of earlier and later and of past and future belong to appearance, and not to reality, the real order will be a series, but a series without change and without time. The psychological theory of the "specious present" was criticised, and also the scientific concept of cause. In regard to the first, it was suggested that our consciousness of the present is our point of contact with supra-temporal existence, and that our tendency to identify this experience with the moving line which divides past from future is an error. Immediacy belongs only to a supra-temporal mode of intuition. With regard to the conception of causation, it had been almost driven out of natural science, and it would be a good thing if it were driven out of philosophy too. Time-succession seems to belong to a half-real world and to share its self-contradictions. We are partly in this half-real world and partly out of it. We are enough out of it to know that we are blind on one side, which we should never know if time were real, and we inside it.

CAMBRIDGE.

Philosophical Society, October 25.—Mr. C. T. R. Wilson, president, in the chair.—K. **Tamaki** and W. J. **Harrison**: The stability of the steady motion of viscous liquid contained between two rotating co-axial circular cylinders. It is shown that the steady motion is unstable for one particular type of disturbance, and that a considerable degree of viscosity is needed to give stability in the case of some other modes of disturbance. It is not possible to discriminate on a theoretical basis between the relative stabilities when the inner cylinder is rotating and the outer fixed, and *vice versa*. A criterion suggested by Prof. Lamb is discussed. Further, an explanation is given of the apparent discrepancy between the conclusion of Reynolds that a certain degree of viscosity is necessary for stability and the conclusion of Lord Rayleigh that certain steady motions of an inviscid liquid are stable, without making the assumption that there is a finite difference in behaviour between a viscous and a non-viscous liquid.—M. M. **Riesz** and Prof. G. H. **Hardy**: Le principe de Phragmén-Lindelöf.—G. P. **Thomson**: A note on the nature of the carriers of the anode rays.—M. H. **Cramér**: The distribution of primes.—Prof. G. H. **Hardy**: Note on Ramanujan's trigonometrical function $c_q(n)$, and certain series of arithmetical functions.—L. J. **Mordell**: The representation of an algebraic number as a sum of four squares.—Major P. A. **MacMahon**: The parity of the number which enumerates the partitions of a number.

MANCHESTER.

Literary and Philosophical Society, October 19.—Sir Henry A. Miers, president, in the chair.—C. E. **Stromeyer**: An attempt to explain the real nature of time, space, and other dimensions. The author said that in the remote past doubts seem to have been entertained about the reality of time and space, and of matter it seems always to have been believed that it could be made to appear and disappear. Kant and Schopenhauer were converts to the new belief in the indestructibility of matter, but asserted of time and space that they were functions of the brain. They may, therefore, be looked upon as being the innocent originators of the modern idea that the world is mind and matter. In their days energy and its conservation or indestructibility had not been discovered, but they suspected that besides matter there was another reality which they respectively called "das Ding an sich"—the real thing—and "der Wille zum Leben"—the will to live. They did not explain what they meant by reality, and the author pointed out that they should have said that time and space were relatively unreal to matter and to the "real thing," in the same way that length, breadth, and depth are relatively unreal to space, if this be taken as the standard of reality. The author then said that dimensions, using the term in its widest sense so as to include time, space, velocity, work, pressure, and all the electric, thermometric, and chemical dimensions, were unquestionably factors of energy. Energy always appears as a product of these factors, never as a factor. It stands in marked contrast to every one of its factors in being indivisible quantitatively until it has been divided qualitatively. It cannot be located in the same sense that length may be said to be located in space or a volt in an ampere. Energy, in contrast to its factors or dimensions, seems to be the only "real thing"; all its factors, our world, are relatively unreal, but amongst each other they appear relatively real. Thus, contrary to Kant's and Schopenhauer's views, matter is both as real and as unreal as are time and space. The author also dealt with the fourth dimension, and showed that it was not a real one.

EDINBURGH.

Royal Society, October 25.—Prof. F. O. Bower, president, in the chair.—The president delivered an address on "Size: A Neglected Factor in Stelar Morphology." The purpose of the address was the application of the principle of similar structures to certain internal tissues of plants. The principle had been used by zoologists to explain certain peculiarities of the animal body, both external and internal. Botanists had been slower to use it in relation to plants, though it had been pointed out that the limit of size of trees is imposed by the fact that the strength of the trunk increases only as the square, while the weight increases as the cube, of the dimensions. The same relation holds for the limiting surface of internal tissues in proportion to their bulk; as the size increases the surface varies as the square, while the bulk of the tissues enclosed varies as the cube. If, then, interchange of soluble substances through the limiting surface be proportinnal to its area, as the size is increased there will come a limit beyond which further increase is impossible unless the form be altered. This general position was used to explain the very complicated vascular system in certain plants, especially the ferns. The breaking up of their vascular tracts into curiously elaborate masses was held to be a necessary consequence of the need for increased proportion of surface to bulk in the larger forms. It was also exemplified in certain roots of palms and other plants. The reason why the difficulty did not arise in ordinary tree-trunks was that after the early stages the strict limitation of the conducting tracks was broken down. But in fern-stems and palm-roots it was strictly maintained in the adult, and this was what raised the difficulty and accounted for the peculiar structure which they showed.

PARIS.

Academy of Sciences, October 26.—M. Henri Deslandres in the chair.—P. **Appell**: The ellipsoidal oscillations of a liquid sphere.—P. **Termier** and W. **Kilian**: The tectonic signification of the fragments of mica schists, various crystalline rocks, and green rocks which crop out here and there near Briançon in or at the surface of strata of Briançon facies.—C. **Nicolle** and E. **Conseil**: The preventive vaccination of man against Mediterranean fever. Experiments on human subjects showed that it is easy to vaccinate preventively by subcutaneous inoculations of dead cultures. The duration of the immunity has yet to be determined.—R. **Birkeland**: Resolution of the trinomial algebraical equation by higher hypergeometrical functions.—M. **Zervos**: Some transformations of partial differential equations of the second order.—C. **Camichel**, D. **Eydoux**, and A. **Foch**: The transmission of energy by vibrations of liquids in pipes. M. Constantinescu has recently described his researches on the transmission of energy by means of vibratory waves in a pipe full of liquid. As the methods of calculation have not been published, the author develops the theoretical side of the question by the general method given by Allievi.—A. **Buhl**: The symmetries of the gravific field and the Lorentzian extension of Hamilton's principle.—E. **Jouguet**: The variation of entropy in waves of shock of elastic bodies. The variation of entropy is of the third order at least, and hence for small discontinuities the dynamic adiabatic law of Hugoniot is very near the ordinary adiabatic law.—P. **Dejean**: The Ar_3 point of steels and of martensite. In a recent paper by L. Guillet a diagram by M. Chevenard was given relating to iron-nickel alloys practically free from carbon. For alloys between 0 and 25 per cent. of nickel the curve of the Ar_3 points showed no discontinuity, and this appeared to contradict some earlier results of the authors on the critical points of nickel steels containing 0·2 per cent. of carbon. In the present communication it is proved that the two series of results are not contradictory.—M. **Barlot**: Combinations of the halogen derivatives of lead and thallium. A study of the electrical conductivity of aqueous centinormal solutions of $PbCl_2$ and TlCl indicated the existence of a compound $TlCl.PbCl_2$, and this was isolated by cooling a boiling aqueous solution containing the two chlorides in equimolecular proportions. The crystals separating are of a definite form, but after keeping for some time at the boiling point in presence of a quantity of water insufficient to dissolve it, they decompose into the two constituents, readily identifiable under the microscope. Similarly constituted double bromides and iodides were also prepared.—M. **Godchot**: The systematic degradation of dibasic saturated acids of high molecular weight. The method of Bouvet has been successfully extended to suberic, azelaic, and sebacic acids.—A. **Damiens**: The estimation of traces of bromine in organic materials.—G. **Denigès**: An extremely sensitive colour reaction for phosphates and arsenates: its applications. Traces of phosphates treated with an acid solution of ammonium molybdate and a little stannous chloride develop a blue coloration. Arsenates behave similarly.—M. **Marion**: The action of hydrogen peroxide on flour. Solutions of hydrogen peroxide allowed to react with flour under definite conditions (concentration of hydrogen, peroxide, temperature, and acidity) give off oxygen, and this can serve as a measure of the grade of the flour.—J. **Savornin**: The continental Aquitanian in South Morocco.—P. **Bonnet**: The structure of the Caucasian isthmus and its relations with the oil-fields.—S. **Stefanescu**: The phylogeny of *Elephas meridionalis*.—A. **Danjon** and G. **Rougier**: The spectrum and theory of the green ray. Photographs of the spectrum of the green ray show that the theory of anomalous dispersion is untenable; the results are clearly in favour of the theory of normal dispersion, with absorption of the orange by the moisture in the atmosphere.—C. **Dufraisse** and J. C. **Bongrand**: The measurement of the tear-producing power of irritating substances by the *méthode du seuil*. The "*concentration de seuil*" is the lowest concentration which can be detected by its action on the eye in 30 seconds. This concentration for benzyl bromide is taken as unity in the measurements, and, although observers differ in sensibility, the comparative results expressed in this manner are independent of the observer. Figures are given for the principal lacrymogenic substances utilised in the war.—R. **Wurmser**: The action of radiations of different wave-lengths on the chlorophyll assimilation.—L. **Destouches**: Physiological observations on *Convoluta roscoffensis*.—A. **Krempf**: The larval development of *Coeloplana gonoctena*.—P. **Wintrebert**: The embryonic functions of the apparatus of relation in the anamniotic vertebrates.

NAPLES.

R. Accademia delle Scienze fisiche e matematiche, April 3.—Prof. Monticelli, president, in the chair.—G. **d'Erasmo**: Miocene ichthyolites from Syracuse. A description of four species of Teleostomi new to the fossil fish fauna of the calcareous Miocene deposits of the province of Syracuse, of which one (*Pagellus siracusanus*) is new to science, and also one representative of the Elasmobranchi of the genus Carcharias. The paper is accompanied by a plate of *Sparnodus vulgaris*, *Pagellus siracusanus*, and *Callipterix spinosus*.—M. **Picone**: Riemann's integral and its relation to that of Lebesgue.—E. **Pantanelli**: Elective absorption of ions in equilibrated solutions. This is a sequel to the author's investigations on the absorption of ions by plants, in which he employs new experimental methods to elucidate the complex process of absorption of ions in equilibrated solutions, whether modified by the addition of salts with the object of maintaining the same osmotic pressure as that of solutions in which marine or terrestrial plants live, or in experiments with pure salt solutions.

April 10.—M. **Cipolla**: Hardy's criterion of convergence, ii.

SYDNEY.

Royal Society of New South Wales, September 1.—Mr. J. Nangle, president, in the chair.—G. D. **Osborne**: The volcanic neck at the basin, Nepean River. The general geological features of the neck are discussed and a detailed account of the petrology of the rocks occurring there is given. The neck, which breaks through the Triassic rocks at its surface outcrop, is filled with a fine-grained breccia which is intruded by basalt dykes and plugs. The formation of the neck with the production of a long, narrow vent has been effected by explosive action concentrated upon a weak fissure structure lying transverse to the monoclinal fold in that locality. It has played an important part in the physiographic history of the Warragamba and Nepean river systems in Cainozoic times, the present junction of these two rivers being within it. In the breccia there occur fragments of the peridotites cognate with the basalt, and foreign xenoliths of rhyolite, gneissic granite, and sandy limestone. The basalt contains only cognate inclusions of norites, hyperite, harzburgites, lherzolites, dunites, pyroxenites, and troctolite, the last-named recorded for the first time in New South Wales. The cognate inclusions represent fragments of a differentiate which solidified under plutonic conditions. The rhyolite inclusions may have come from the southward extension of the Kuttung series, the granitic rocks from ancient terrains and the calcareous clastic rocks from a now denuded roof of Upper Wianamatta rocks. Chief among petrographical features are the occurrences of two mineral intergrowths, a granophyric one of pleonaste and diopside and a graphic intergrowth of augite and picotite.—R. H. **Cambage**: Acacia seedlings, part vi. The seedlings of seven Acacia species are described. The author stated that one seed-pod of *Acacia farnesiana* had floated in sea-water for more than eleven weeks and another for more than twelve weeks, and as he had previously demonstrated that a seed of that species would germinate after having been immersed in sea-water for three and three-quarter years, he considered the likelihood of the distribution of this species being sometimes effected by ocean currents was strengthened. The twinning of seedlings of *Acacia asparagoides* was recorded, several seeds having produced twin plants.—J. H. **Maiden**: A box-tree from New South Wales and Queensland. This tree, which is described as a new species, seems to deserve the name of "narrow-leaved box" better than all the boxes, its juvenile leaves being narrow-lanceolate and its mature foliage almost as narrow. The fruits are small and the timber pale brown. It is one of the trees known as "mallee box." It differs from *Eucalyptus bicolor*, which has narrow juvenile foliage, in the red timber and thick bark of the latter, and is widely different from *E. Woollsiana*, R. T. Baker, which has broad juvenile foliage. It has been collected from Gilgandra, New South Wales, to Southern Queensland, and is particularly abundant in the Pilliga scrub. The type comes from Narrabri, New South Wales.

Books Received.

A Naturalist in Himalaya. By Capt. R. W. G. Hingston. Pp. xii+300+plates. (London: H. F. and G. Witherby.) 18*s*. net.

Orographical, Regional, Economic Atlas. Part 2, Europe. Pp. 32. (Edinburgh: W. and A. K. Johnston, Ltd.; London: Macmillan and Co., Ltd.) 1*s*. 6*d*. net.

Wild Friends at Home. By E. Chivers Davies. Pp. 64. (London: G. G. Harrap and Co., Ltd.) 6*s*. net.

A First Trigonometry. By Winifred Waddell and Prof. D. K. Picken. Pp. vii+78. (Melbourne: Melville and Mullen Pty., Ltd.)

A Critical Revision of the Genus Eucalyptus. By J. H. Maiden. Vol. iv., parts 31-40. (Index.) Vol. v., part 2. Pp. 23-70+4 plates. (Sydney: W. Gullick.) 2*s*. 6*d*.

Lehrbuch der Mineralogie. By Prof. P. Niggli. Pp. xii+694. (Berlin: Gebrüder Borntraeger.) 80 marks.

L'Ether pur, l'Ether matériel et les trois formes fondamentales de l'Energie. By Paul Elmassian. Pp. 304. (Genève: Impr. Atar.)

Mathematics for Technical Students. By S. N. Forrest. Junior Course. Pp. viii+260. (With Answers.) (London: E. Arnold.) 7*s*. 6*d*. net.

The Experimental Basis of Chemistry. By Ida Freund. Pp. xvi+408. (Cambridge: At the University Press.) 30*s*. net.

Diary of Societies.

THURSDAY, NOVEMBER 18.

ROYAL BOTANIC SOCIETY, at 3.—Prof. A. W. Bickerton: The Relations of Astronomy to Botany. (2) The Value of Basic Principles.
ROYAL SOCIETY, at 4.30.—Sir Arthur Schuster: The Absorption and Scattering of Light.—Prof. O. W. Richardson: The Emission of Electrons under the Influence of Chemical Action.—Dr. A. E. Oxley: Magnetism and Atomic Structure. I.—Prof. A. O. Rankine: The Proximity of Atoms in Gaseous Molecules.—Prof. A. O. Rankine: The Similarity between Carbon Dioxide and Nitrous Oxide.—Dr. A. M. Williams: Forces in Surface Films. Part I., Theoretical Considerations; Part II., Experimental Observations and Calculations; Part III., The Charge on Colloids.
LINNEAN SOCIETY, at 5.—Prof. E. S. Goodrich: A New Type of Teleostean Cartilaginous Pectoral Girdle found in young Clupeids.—Dr. J. C. Willis: Endemic Genera and Species of Plants.
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.—L. Damblanc: The Problem of the Helicopter.
ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.
INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—J. Morrow Campbell: The Origin of Primary Ore Deposits (Adjourned Discussion).—H. C. Robson: Converting High-grade Matte in Magnesite-lined Converters.—C. Brackenbury: An Automatic Counting Machine for Checking Tram Wagons.
CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. F. G. Crookshank: The Anthropological Study of the Feeble-minded, or Imbeciles and Apes.
INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Ll. B. Atkinson: Inaugural Address.
INSTITUTION OF AUTOMOBILE ENGINEERS, at 8.—London Graduates' Meeting.
CHEMICAL SOCIETY, at 8.
WIRELESS SOCIETY (at Royal Society of Arts), at 8.—A. A. Campbell Swinton: Address.
RÖNTGEN SOCIETY (in Physics Lecture Theatre, University College, Gower Street), at 8.15.—Dr. R. Knox: Presidential Address.

FRIDAY, NOVEMBER 19.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.—Sir William Milligan: Chronic Catarrhal Otitis Media; Some Thoughts and Suggestions.
INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Capt. J. S. Arthur: Sterilisation of Water by Chlorine Gas.
INSTITUTION OF ELECTRICAL ENGINEERS (Students' Section) (at City and Guilds (Eng.) College, Exhibition Road), at 6.30.—C. C. Paterson: The Incandescent Electric Lamp from the Inside.
JUNIOR INSTITUTION OF ENGINEERS, at 7.—G. H. Ayres and Others: Discussion on Economical Transmission of Power.
ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Sections), at 8.30.—Discussion: Radio-therapy; Prof. S. Russ: Physics.—Dr. Batten: Superficial Therapy.—Dr. Finzi: Deep Therapy.

SATURDAY, NOVEMBER 20.

PHYSIOLOGICAL SOCIETY (at St. Bartholomew's Hospital), at 4.

MONDAY, NOVEMBER 22.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.
ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Major F. M. Bailey: A Visit to Bokhara in 1919.
MEDICAL SOCIETY OF LONDON (at 11 Chandos Street, W.1), at 8.30.—Dr. F. J. Poynton, Dr. D. H. Paterson, and Dr. J. C. Spence: A Study of an Outbreak of Acute Rheumatism in Children under 12 Years.—Dr. G. E. S. Ward: Some Disorders of the Myocardium (illustrated by the electro-cardiograph).

TUESDAY, NOVEMBER 23.

ROYAL BOTANIC SOCIETY, at 3.—Prof. A. W. Bickerton: The Relations of Astronomy to Botany. (3) Complex Changes of Season and Climate.
SOCIOLOGICAL SOCIETY (at 65 Belgrave Road), at 5.15.—C. R. Enock: Suggestions towards a Science of Corporate Life.
ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.30.
INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—Short Chemical Papers.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Technical Meeting), at 7.—W. T. Wilkinson: The Wet Collodion Process Demonstrated, and an Incursion into Litho-Photography.
ROYAL ANTHROPOLOGICAL INSTITUTE (at Royal Society), at 8.30.—Dr. A. C. Haddon: Migrations of Cultures in British New Guinea. (Huxley Memorial Lecture.)

WEDNESDAY, NOVEMBER 24.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section) (at Institution of Civil Engineers), at 6.—Dr. W. H. Eccles: Address.
ROYAL SOCIETY OF ARTS, at 8.—Dr. F. W. Edridge-Green: Colour Vision and Colour Blindness.
INSTITUTE OF CHEMISTRY (in Chemical Theatre, University College, Gower Street), at 8.—J. Turney Wood: Some Scientific Aspects of Tanning.

THURSDAY, NOVEMBER 25.

ROYAL SOCIETY, at 4.—Special General Meeting to consider the Annual Report of Council.—At 4.30.—*Probable Papers.*—Prof. L. Hill: The Growth of Seedlings in Wind.—Prof. P. T. Herring: The Effect of Thyroid-feeding and of Thyro-parathyroidectomy upon the Pituitrin Content of the Posterior Lobe of the Pituitary, the Cerebro-spinal Fluid, and Blood.—W. A. Jolly: Reflex Times in the South African Clawed Frog.—Prof. J. A. Gunn and R. St. A. Heathcote: Cellular Immunity. Observations on Natural and Acquired Immunity to Cobra Venom.—L. T. Hogben: Studies on Synapsis. III. The Nuclear Organisation of the Germ Cells in *Libellula depressa*.
CHADWICK PUBLIC LECTURES (at the Medical Society of London), at 5.15.—Prof. J. B. Farmer: Some Biological Aspects of Disease.
INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—W. B. Woodhouse: The Distribution of Electricity.—R. O. Kapp: Some Economic Aspects of E.H.T. Distribution by Underground Cables.
EGYPT EXPLORATION SOCIETY (at Royal Society), at 8.30.—Prof. G. Elliot Smith: The Royal Mummies.
ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.

FRIDAY, NOVEMBER 26.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 5.
INSTITUTION OF ELECTRICAL ENGINEERS (Students' Section) (at the City and Guilds Technical College, Leonard Street, E.C.), at 6.30.—A. J. C. Watts: Electricity and the Paper-making Industry.
OPTICAL SOCIETY AND PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 7.—The Making of Reflecting Surfaces. (*a*) Technical Methods and Process. (*b*) Properties of Reflecting Surfaces (Reflecting Powers, etc.).
ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.30.—Dr. A. Chaplin: Measures for Preserving the Health of Seamen on Board Ship.

CONTENTS.

THURSDAY, NOVEMBER 25, 1920.

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British Dyes.

In view of the present large importation of German dyes into this country, a strong appeal for the protection of the British dye industry is made by Dr. Herbert Levinstein in the *Morning Post* of November 19. Dr. Levinstein points out that the pledge given by Sir Albert Stanley, President of the Board of Trade, on May 15, 1918—namely, that the importation of all foreign dyestuffs should be controlled for a period of not less than ten years after the end of the war—has never been redeemed, and adds: "Nobody suggests that a prohibition of imports except under licence should be permanent. Ultimately, the industry must flourish on its own merits, prosper by its efficiency, by the originality of its inventions, and by the scale of its operations."

It would seem to be a simple matter for the Government to allow imports under licence of such dyes as are required, but not yet manufactured, in this country, and to exclude those which can be shown to be produced here in adequate amount. That the position is not quite so simple as would appear from this is shown by the statement of the Prime Minister so recently as November 11, to the effect that no guarantee could be given that this measure would be brought in before Christmas unless it could be shown that the measure was non-contentious, and by Dr. Levinstein's own very serious and alarming statement that since July last, owing to the large importation of German dyes which has taken place, a great injury has already been inflicted on the dye industry, and consequently on the textile industries. Progress has been arrested, developments brought to a standstill, great plants closed down, and large numbers of workmen thrown out of employment. At the same time, whilst in July, 1914, the German supplies were above 80 per cent. of the dyes used in this country, in July last the output of the British Dyestuffs Corporation, Ltd., was greater in quantity, though less in variety, than the total quantity of dyes imported from Germany in July, 1914.

The only conclusion that can be drawn from the Prime Minister's statement is that opposition exists to the apparently logical measure which the dye manufacturers desire to see introduced, and this can come only from the dye users. Dr. Levinstein's statement shows, further, that German dyes, of the same kind as are being manufactured here, are being bought on the large scale in preference to the dyes made at Huddersfield and Manchester. Evidently the dye users have a very strong preference for German dyes, even of the commoner kind. It was to be expected that the more complicated dyes which the Germans produce, but which are not yet made in this country, would be eagerly acquired by the dye users when available, but that the British Dyestuffs Corporation would be compelled to close down great plants and discharge large numbers of workmen immediately following importation from Germany was not anticipated, and is a matter of most serious moment.

There can be only two reasons for this: either the products made by the British Dyestuffs Corporation are not of the same quality as the German, or they are of the same quality, but must be sold at a higher price. Dr. Levinstein suggests that the latter is the case, for he says: "Owing to the depreciation of the mark, they [the Germans] can undersell any English makers, and yet make large profits." Whatever may be the depreciation in the value of the mark, it does not appear that the Germans are underselling the English manufacturers. As was stated recently in these columns, the average price of the 1500 tons of German dyes mentioned in the House of Commons as having been imported during the first nine months of this year was 7*s.* 11*d.* per lb. Even supposing that part of this quantity consisted of very highly priced dyes, presumably not manufactured here, yet the quantity of the cheaper class of dyes must have been large if, as we may presume, they were at least partly responsible for the collapse referred to by Dr. Levinstein, and, therefore, their average price could not have been very much less than 7*s.* 11*d.* When it is considered that the average pre-war price of the majority of dyes advertised at present by the British Dyestuffs Corporation was very much nearer 1*s.* than 8*s.*, it is difficult to imagine that there can be such underselling as is suggested.

On the other hand, will the dye users say that the quality of the dyes made at Huddersfield and Manchester is equal in every respect to that of the pre-war (and present) German product? Although the shade of the dyes is probably the same—and there is no doubt that the product made by the chemist in the works is fully equal to the German—this product must necessarily be reduced, by adding salt or other inert material, to a given standard. Precision and exactness in seeing that all deliveries conform to this standard of strength are of vital importance to the dyer, and divergence from this may well lead him to seek his supplies elsewhere.

Antarctic Research.

(1) *Scottish National Antarctic Expedition: Report on the Scientific Results of the voyage of S.Y. "Scotia," during the years* 1902, 1903, *and* 1904, *under the Leadership of Dr. William S. Bruce.* Vol. vii., Zoology; parts i.–xiii., Invertebrates; pp. viii+323+15 plates. (Edinburgh: The Scottish Oceanographical Laboratory, 1920.) Price 50*s.*

(2) *British Museum (Natural History). British Antarctic ("Terra Nova") Expedition,* 1910. *Natural History Report. Zoology.* Vol. xi., No. 9. Mollusca. Part iii., Eupteropoda (Pteropoda Thecosomata) and Pterota (Pteropoda Gymnosomata). By Anne L. Massey. Pp. 203–232: No. 10. Mollusca. Part iv., Anatomy of Pelecypoda. By R. H. Burne. Pp. 233–256+4 plates: vol. iv., No. 3. Echinoderma (part xi.) and Enteropneusta. Larvæ of Echinoderma and Enteropneusta. By Prof. E. W. MacBride. Pp. 83–94+2 plates. (London: British Museum (Natural History), 1920.) Prices 7*s.* 6*d.* and 8*s.* 6*d.*

(1) THE seventh volume of the results of the successful voyage of the *Scotia,* under the able leadership of Dr. W. S. Bruce, contains a series of interesting memoirs. Mr. Pearcey identifies 267 species of Foraminifera, eleven of which are new. He thinks the group richer south of 70° than north of it, and that the Foraminiferal fauna of the arctic and antarctic regions is strikingly similar, from the generally uniform conditions of temperature extending over the bottom of the deep sea (*more* Sir J. Murray). The collection was especially rich in Sponges, which are ably described, with excellent figures, by Prof. Topsent. Ten Hexactinellids were obtained, including new species of Malacosaccus, Acæocalyx, Docosaccus, and Caulophacus, the size of the first and last being remarkable, whilst the wonderful megascleres and microscleres enhance the interest of the group.

The antarctic seas abound in Tetractinellids, though the *Scotia* procured only three known forms. The Monaxonida are grouped as antarctic and subantarctic. Amongst the striking forms is *Cladorhiza thomsoni*, a relation of the interesting little Cladorhiza of the *Challenger,* which was sent as an Alcyonarian to Prof. Arthur Thomson, of Aberdeen. The author repeats his antagonism to the bipolarity theory by pointing out the richness of the antarctic region in Hexactinellids and their paucity in the arctic seas. The wide distribution of the Siphonophores Porpita, Velella, Physalia, and the Diphyidæ is shown by J. H. Koeppern. An elaborate memoir on the structure and relationships of the Hexactinian Porponia, Hertwig, is given by Prof. Carlgren, of Lund, showing, amongst other things, its close connection with Halcuria, mesenteries in both occurring regularly in the endocœls. The new species is *P. antarctica.*

Five species of stony corals are dealt with by Prof. Stanley Gardiner, the most important being a new species, *Madracis scotiae,* from the Abrolhos Bank. Mr. Laidlaw notices the pelagic Polyclad Turbellarian, *Planocera pellucida,* from St. Paul's Rocks; whilst Mr. Pringle Jameson describes the Chætognaths, the wide distribution of which, and the large size of *Sagitta gazellae,* are noteworthy. Mr. L. N. G. Ramsay again takes up the Nereids (Polychæts), of which there were six known forms and one new—*N. falklandica.* The peculiar genus Sclerocheilus receives important treatment from Prof. Ashworth, and a new form, *S. antarcticus,* is described. Miss Helen Pixell (Mrs. Goodrich) gives a careful account of the four Sabellids and the six Serpulids. The resemblance in certain respects of Ehlers' Sabellid genus Potamis to the genus Jasmineira, St. Joseph, merits further attention.

Mr. Tattersall deals with the Schizopods, Stomatopods, and non-antarctic Isopods, together with a few Schizopods collected by the *Discovery* in the tropical Atlantic. A new Boreomysis and the re-discovery of *Exosphaeroma tristense,* Leach, are interesting. The occurrence of a new species of the primitive Dorid, Bathydoris, has enabled

Mr. J. T. Evans to give an account of its anatomy, which is in the main Doridiform, though the length of the nerve-collar, the position of the cerebral ganglia, and the absence of separate gastro-œsophageals diverge, and point to a condition earlier than that in the Pleurobranchids and Tritonia. The fusion of the ganglia of the visceral loop, again, is a modern feature, like the loss of the eyes in deep water.

(2) The three parts of the zoology of the *Terra Nova* antarctic expedition published by the British Museum comprise the anatomy of the Pelecypoda by Mr. R. M. Burne, viz. the structure of the Filibranchiate Arcidæ, Pectinidæ, and Limidæ, that of the Eulamellibranchiate Carditidæ, Veneridæ, and Anatinidæ, and traverse much of the ground worked by Pelsener. A curious feature is the occurrence of a finger-shaped glandular cæcum on each side behind the mouth in Lissarca, Adacnarca, and Philobrya, in connection with a ridge of modified epithelium between the body and the gill-axis. The presence of vestigial cephalic eyes in these and in Barbatia is also noteworthy, and the author thinks that at 250 fathoms their function may be other than that connected with light. The incubation of eggs in the mantle cavity in Adacnarca, in the supra-branchial chamber of Anatina, and in the interlamellar space in Venericardia is rare in marine Lamellibranchs, and may be an antarctic habit.

In her report on the Pteropods, Miss A. L. Massey adopts the terms of Boas, viz. Eupteropoda and Pterota for the older Thecosomata and Gymnosomata, since they are really not closely related, except for the presence of fins. All the seventeen specimens are known forms. If Bonnevie's view is correct, some species frequent the surface and others occur in the deeper water, so that surface-netting only might explain the absence of the latter. Miss Massey, however, does not allude to possible changes of vertical distribution from temperature, storms, light, or darkness. The materials have been worked out most carefully, structurally and otherwise. The wide distribution of Limacina and Clione suggests the possibility that several species of the former may yet be reduced to varieties, as Vayssière holds, and the same may be said with respect to *Clione limacina* and *C. antarctica*.

Prof. MacBride's description of the Larvæ of Echinoderma and Enteropneusta includes four species of the former, two of which, a Bipinnaria and an Auricularia, are new, whilst the latter is represented by a species of Tornaria. It is noteworthy that he was enabled, by the examination of *Auricularia antarctica*, to confirm H. Bury's original view that the anterior division of the cœlomic sac does not become directly converted into the hydrocœle. The latter grows out as a bud from its hinder aspect. Interesting points in the structure of *Auricularia nudibranchiata* are given, demonstrating that Chun's interpretations of the hydrocœle were erroneous; and what he thought to be a median pouch of the intestine is really double, so that the larva cannot belong to the Elasipoda, in which the diverticulum is single. Two examples of Tornaria furnished the author with stages in the development of the so-called "glomerulus," or "proboscis gland." He terms the glandular tissue around the blood-space "heart-gland," which he thinks an organ of internal secretion. All the three memoirs are illustrated by excellent figures.

W. C. M.

The Physiology of Pregnancy.

Radiant Motherhood: A Book for Those who are Creating the Future. By Dr. Marie C. Stopes. Pp. 246. (London: G. P. Putnam's Sons, Ltd., 1920.) Price 6*s*. net.

THE publication of the report of the Royal Commission on Venereal Diseases in 1916, and of two reports by the National Birth-rate Commission in 1916 and 1920, if it did not in itself bring in a new era of frank, open discussion of what had been regarded as the secrets of *la vie intime*, at any rate gave to that era official recognition, and perhaps something also of the nature of a benison. When, further, it became evident that civilised mankind (including womankind) had begun to show its intense interest in its own reproduction by experimenting upon it, and even by attempting to control it, it followed with an almost gravitational certainty that individuals would in separate volumes set forth the hitherto unrevealed aspects of such subjects, and would each try to outdistance competitors in what may be called a race to lay bare all the phenomena of the sexual relations which precede and of the obstetrical results which follow (when they are permitted) the cohabitation of man and woman.

Dr. Marie C. Stopes is one of the authors who have trodden this path in literature in her earlier works, entitled "Married Love" and "Wise Parenthood," and now in her latest book, which she has named "Radiant Motherhood." She is a doctor of science, London, a doctor of philosophy, Munich, a fellow and lecturer in palæobotany in University College, London, and she was a member of the National Birth-rate Commission when it was preparing its second report; but she lays no claim on her title-pages to the possession of any medical qualification or obstetrical diploma. These restrictions may not to the author seem to matter much, but they inevitably lessen the value to be assigned to the more strictly medical and obstetrical portions of her work.

For example, on p. 34 Dr. Stopes writes of the tendency for the head of civilised man to get larger and so to make the birth of the babies of the future through "the gateway of pain" (*i.e.* the mother's pelvis) almost impossible unless Cæsarean section, which may have become a racial necessity by that time, is perfected; but on p. 155 she ascribes the survival of more girl than boy babies to the strength of the former, apparently forgetting her conclusions about "the gateway of pain," for surely the heads of the boy babies (who weigh on an average more than the girl babies) are more likely to be compressed injuriously in their exit.

A careful reading of the whole book leaves the reviewer in two minds whether to praise it on account of the many beautiful and far-seeing thoughts in it and the practical suggestions it contains for the relief of the distresses and difficulties of expectant mothers and fathers, or to censure it for the impracticability of many of its recommendations and for the lack of distinction between matters which have been fairly well established and those which are little more than speculations. It is only fair, however, constantly to bear in mind that the appeal of the book is pre-eminently to the "young happy and physically well-conditioned pair who, mating beautifully on all the planes of their existence, are living in married love" (p. 13), and to "middle- and upper-class women" (p. 168). With this group as audience it is less surprising to read that for the man who "desires to have a child who may become one of the *master* minds" it is wise "to mate himself with the long-young late-maturing type of woman and let her bear that child some time between the age of thirty-five and forty-five." At the same time, even that type of woman within these years is likely to have rigidity of the "gateway of pain" just as any other elderly primipara has, so the expected "master mind" may come to be a still-birth. All the way through her book Dr. Stopes is impeded by the confusion of thought which reigns when one group of parents is being advised and another is being scolded. The radiant motherhood which is written about is for the few. This becomes clear when we read (p. 50) that "the ideal way of spending the earlier months of coming parenthood is in the form of an extended honeymoon, in which the couple, travelling slowly, should follow the guide of seasonal beauty," etc.; that the fertilising union should take place "on a holiday into wild and inspiring solitudes"; and that after giving birth to her child the mother "should lie about for the whole of six weeks" (p. 174).

With two very difficult subjects Dr. Stopes deals in her own way. In the chapter which she calls "The Weakest Link in the Human Chain," she tries to decide the best way of answering the child when he or she asks about sexual and reproductive matters. She cuts the Gordian knot by recommending that "the child's first instruction in its attitude towards its sex-organs, its first account of the generation of human beings, should be given when it is two or three years old"; and she adds: "A child so tiny will usually not remember one word of what was said to it, but the effects on his outlook will be deep." The other difficult question is that of sexual connection during pregnancy. Several of the chapters contain very useful advice, and that (the tenth) on the physical difficulties of the expectant mother is full of such; but is Dr. Stopes aware that at antenatal clinics these things are being commonly taught to all expectant mothers, sometimes with quite usefully irradiating effects? Not a few obstetricians believe that morning sickness and some of the other impedimenta of pregnancy are preventable.

In other chapters, as has been hinted already, the author reveals a rather extraordinary readiness to consider strange stories, such as that Oscar Wilde's character was determined by thoughts which his mother cherished about him whilst she was carrying him in her womb. Some of her suggested remedies for existing evils are sound, although difficult of accomplishment, such as the endowment of motherhood; but the sterilisation of the unfit by Acts of Parliament might tend to do what she herself condemns so much—the manufacturing of revolutionaries. Her suggestion of a safe method of controlling parenthood by preventing conception is taken for granted in this volume; it was described in detail in an earlier one.

Roscoe and Schorlemmer's Chemistry.

A Treatise on Chemistry. By the Rt. Hon. Sir H. E. Roscoe and C. Schorlemmer. Vol. i., *The Non-metallic Elements.* Fifth edition, completely revised by Dr. J. C. Cain. Pp. xv+968. (London: Macmillan and Co., Ltd., 1920.) Price 30*s.* net.

IT is forty-three years since the first edition of Roscoe and Schorlemmer's "Treatise on Chemistry" appeared. The volumes on Organic Chemistry have now passed out of general use, but those on Inorganic Chemistry show no sign of any decline in popularity, and maintain their position almost unchallenged as the standard work on chemistry in the English language. It is not easy at the first attempt to discover what are the special qualities that give to Roscoe's book this attribute of perpetual youth and long-sustained utility, but the refusal of the author to sacrifice either clearness of exposition or scholarly writing in order to reduce the size of the treatise, or to overcrowd its pages with detail, has perhaps been one of the most important factors in securing these enviable attributes. Thus it is still possible to turn to the work for the detailed story of the investigation of the fixed or variable oxygen-content of the atmosphere, or of the composition of the distillate from hydrochloric acid, without finding that the narrative has been so abbreviated as to be valueless except as a guide to the original papers. The editors of successive editions must have exercised considerable restraint in order to allow a full account to be preserved of experiments which were becoming too old to be modern, but were still too modern to be classical.

In bringing out the new edition, Dr. Cain has been handicapped by the fact that he has no longer been able to refer his work to Roscoe himself for approval; but, having been associated with Roscoe in the preparation of the preceding edition, he has had special advantages in striving to preserve the character and style of the book, and has succeeded so well in his task that the later dates which now appear in the footnotes are the most conspicuous marks of modernity. Here and there a paragraph remains which shows signs of obsolescence, and in an occasional instance (*e.g.* the electrical method of making carbon disulphide) modern work has escaped notice; but the new edition is a worthy successor to those that have gone before, and will contribute its share to the long life of the treatise.

One fault which was formerly characteristic of Roscoe's "Chemistry" has almost disappeared in the new edition—namely, the conversion of classical apparatus into a modern form, without any indication in the text of the transformation that had been effected. Only one example of this curious process appears to have survived—namely, the introduction of a gas furnace with a row of Bunsen burners in the figure illustrating the experiments on the composition of air carried out by Dumas and Boussingault in 1841, although the joints of the apparatus are still shown with the original rubber bandages instead of rubber tubing. This last link with an old tradition will perhaps be broken when the time comes for a sixth edition to appear.

It is some satisfaction that the printing and paper show no sign of deterioration, so that the appearance of the book is as attractive as in former years. Roscoe's "Chemistry" has never stooped to the use of black type as a means of emphasis, nor to the use of smaller type for matter of less importance. Even the conventional division of the text into chapters is missing. These features have given to the book a character of its own, which clearly appeals to the more scholarly type of reader, even if the student finds that he is obliged to read the book instead of skimming through it from one key-word to another. The student will still find, however, that he has in Roscoe the best available guide to the literature of inorganic chemistry, directing his attention to all the more important papers, and passing lightly over the mass of detail which has converted so many of the larger works from text-books into dictionaries. Roscoe's "Chemistry," in spite of its increasing size, still possesses all the essential qualities of a book rather than of a catalogue, and this is perhaps the principal reason why its approaching jubilee is unaccompanied by any marks of old age.

T. M. L.

Archimedes.

Archimedes. By Sir Thomas Heath. Pp. ii+58. (Pioneers of Progress Series.) (London: S.P.C.K.; New York: The Macmillan Co., 1920.) Price 2*s.* net.

BY the general consent of all competent judges Archimedes is one of the greatest mathematicians the world has ever seen. It is not easy to justify this opinion to a popular audience, most members of which know little and care less about mathematics; but Sir Thomas Heath's book ought to succeed in making the ordinary reader understand to some extent the nature of Archimedes' discoveries, and in arousing interest in the achievements of Greek mathematicians.

Chap. i. gives such fragmentary (and often legendary) notes as we have on Archimedes' personal career; chap. ii. is an excellent account of Greek geometry before Archimedes' time; chaps. iii.–vii. give analyses of Archimedes' extant works. Special attention may be directed to the paragraphs (pp. 31–35) on the "Method," discovered by J. L. Heiberg so lately as 1906 in a palimpsest at Constantinople. This work shows how Archimedes was led to some of his theorems by quasi-mechanical considerations. It should be observed that Archimedes does not give a so-called "statical proof" of any purely geometrical theorem; this would be contrary to Greek ideas of mathematical propriety. But the theorem having suggested itself as probable from mechanical (or other) considerations, strict methods were applied to test it—such, for instance, as the process of "exhaustion." In connection with this exhaustion method it is properly pointed out that the Greeks virtually laid the foundations of the integral calculus, much in the same way as Apollonius, in his "Conics," virtually anticipates the results of modern analytical geometry.

Scattered about the book there are numerous references to Greek discoveries and speculations which are not so well known as they ought to be. Thus Archimedes determined the angular diameter of the sun to a comparatively close degree of accuracy (p. 47); Aristarchus of Samos enunciated the Copernican hypothesis (p. 46); and, of course, all mathematicians of the time assumed the earth to be a sphere, and had a very fair idea of its dimensions.

The book is well printed and attractive in appearance; it is adorned by a frontispiece which is a reduced facsimile of that in Torelli's edition of Archimedes' works. The original is a good example of eighteenth-century copper-plate—amusing in one respect, because, although the landscape is put into proper perspective, two mathematical diagrams supposed to be drawn on the sand are drawn in their proper shape in the plane of the paper. The process reproduction appears to be very satisfactory, considering the amount of reduction involved. G. B. M.

Australian Meteorology.

Australian Meteorology: A Text-book, including Sections on Aviation and Climatology. By Dr. Griffith Taylor. Pp. xi + 312. (Oxford: At the Clarendon Press, 1920.) Price 12*s*. 6*d*. net.

THIS text-book of meteorology is written for readers in the southern hemisphere, where, as the author truly points out, European and American text-books are to some extent inapplicable by reason of the fundamental difference in the wind circulation around centres of high and low pressure in the two hemispheres. The examples introduced for purposes of illustration in the present work are mainly drawn from Australian conditions, though the author's wide knowledge of world climatology is also freely used. The 300 or so pages of the book are divided into twenty-six chapters, which cover the practical work at observing stations, as well as the more theoretical aspects of dynamical meteorology and climatology. The author has achieved his object in producing a work which will give the reader of fair intelligence, but without advanced knowledge of mathematics or physics, a good general grounding in the subject. In this connection the pages devoted to pressure gradient and Ferrel's law may be particularly commended. One or two parts are less satisfactory, and in particular the reviewer suggests that in a future edition the chapter devoted to upper-air research might be recast, giving less space to the methods employed, and more to the very important results which have been obtained during the past few years in this field. At the same time, a little more attention might be devoted throughout the book to defining the technical terms used, and to explaining in more detail a few of the less obvious types of diagram, which do not at first glance convey much meaning to the unaccustomed reader.

In chap. xviii. a novel theory is put forward to account for the origin of the tropical lows which form over Australia and drift away to the south-eastward. The theory postulates that domes of warm ascending air are formed over the hottest inland regions in summer, and that the upper north-westerly current, striking these fixed domes, forms gigantic eddies which pass away to the south-eastward, being marked at the surface by a low-pressure centre and often by falls of rain. Any theory of the formation of depressions will be received with interest. The one here put forward is certainly not lacking in originality. It is surprising to learn that the words "backing" and "veering" are used in Australia in the sense of turning against and with the sun respectively instead of with the meanings counter-clockwise and clockwise as recommended by the International Meteorological Committee in 1905. In a modern text-book of meteorology one misses any reference to G. I. Taylor's eddy conductivity. In dealing with the diurnal change of wind at the surface and in the lower layers the simple convection theory of Espy is referred to, but no reference is made to the more complete explanation put forward by G. I. Taylor, in which the observed facts are well accounted for on the reasonable assumption of a diurnal variation of "K."

In his preface the author offers a half apology for the roughness of the diagrams with which the book is illustrated, but this seems scarcely necessary, as the numerous figures form one of its most valuable features, being mainly of small size, and yet showing just the details required to illustrate the point under discussion. J. S. D.

Our Bookshelf.

Elementary Practical Biochemistry. By Prof. W. A. Osborne. Pp. v+184. (Melbourne: W. Ramsay, 1920.)

This book represents the course of elementary instruction in practical biochemistry which the author has found suitable for large classes. The conception of biochemistry is, however, limited to the chemistry of the animal body, so that the title may prove misleading. The work actually comprises a course of elementary physiological chemistry, and is divided into twenty-six lessons, each representing a period of laboratory work. A short statement on the theory of the subject of the exercise is given, followed by directions for the practical work. The latter is almost wholly qualitative in nature, and consists of the usual test-tube experiments on the properties of the chief constituents of the animal body. This mode of treatment is always open to the criticism that the theoretical discussions are too short to be of real value, and it is, indeed, difficult to imagine that the small amount of space allotted, *e.g.*, to the carbohydrates will be of much teaching value. On the other hand, they serve a useful purpose in refreshing the student's memory, so that the tests are more intelligently performed.

We note that the author still uses the term "lipoid," and includes the sterols under this head, in spite of the recent suggestion for the abolition of this term. The question of hydrogen-ion concentration is not touched upon, and this constitutes a serious defect, as this conception is of great importance, even for elementary students, and the work on ferments, proteins, and colloids suffers greatly from its omission.

Dietetics receives a good share of attention, and a useful appendix is given containing an elaborate table of food values. Within the limitations of the author's scheme the treatment is quite adequate, but it is to be regretted that more attention is not paid to quantitative and preparative work. A. H.

Monograph of the Lacertidae. By Dr. George Albert Boulenger. Vol. i. Pp. x+352. (London: British Museum (Natural History), 1920.) Price 2*l.*

This volume comprises only forty species, but it contains the important genus Lacerta, and this has been submitted to an intensive study of the individual variations of the species and their many varieties. The author rightly calls the available material unique in its vastness, due, we may add, to his untiring, purposeful exertions during the many years he has been in charge of the cold-blooded vertebrates in the national collection. He deemed it important to ascertain the extent of variation of which a given form is susceptible and in what direction a given variation trends, and then to decide what characters have been modified, or lost, and what new ones produced.

The way in which certain combinations of orthogenetic and adaptive modifications have, by their recurrence, led to various parallel series is of prime importance. Ten characters, mostly concerning the scaling, have been selected to show from what each has arisen, whither it trends, and how the resulting combinations have produced thereby those recognisable varieties of the several species, and then in turn the genera, which have been evolved from the more central or older genus Lacerta. To trace all this required immense study of the numerical variations in the Lepidosis, as attested by the tens of thousands of measurements.

Lastly, "if the interpretation of these evolutionary series of lizards is at all sound, a step will have been made in the advance of our knowledge, and a more rational basis laid down for the discussion of the probable mode of geographical dispersion of the genera, species, and varieties."

The Centenary Volume of Charles Griffin and Co., Ltd., Publishers, 1820–1920. With Foreword by Lord Moulton. Pp. xx+290+plates. (London: Charles Griffin and Co., Ltd., 1920.)

As a member of the council of trustees of a public library, the present writer has often smiled when the name of Messrs. Charles Griffin and Co. has been accepted as the guarantee of a book rather than that of the less known but aspiring author. He well remembers an interview with Miss Elizabeth Eaves Griffin, who selected him, after the manner recorded on p. 8 of this memorial volume, to prepare a very dry and formal text-book, because she had read a sketch of midnight travel written by him in a school magazine. No wonder, then, that he joins with many others in applauding the perspicacity of the firm. It was a happy thought to bring together its history, told by writers who understand what scientific progress means. Prof. Beare thus deals with engineering, Sir W. Abell with naval architecture, Prof. Gowland with metallurgy, and Prof. Louis with mining. In each case the works published in Exeter Street are mentioned in connection with researches and technological developments that have affected the world at large, and the excellent portraits of authors, such as those of Sir W. Roberts-Austen, Sir Edward Reed, and Mr. Alfred Brothers, are a pleasing record in themselves. The founders and directors of the house are also happily represented, and Mr. F. J. Blight is revealed to us in a welcome moment when he is not called upon to write his well-known signature. The book rightly characterises many of the works issued as "pioneers." It is edited with as much good taste as is shown in its technical production.

Rudiments of Electrical Engineering. By Philip Kemp. Pp. viii+255. (London: Macmillan and Co., Ltd., 1920.) Price 6*s.*

This book is intended for those with practically no electrical knowledge, but whose daily work brings them into touch with electrical apparatus. The recent rush of students to join classes in elementary electrical engineering in technical schools shows that there is a demand for this knowledge. We think, however, the author has included too much in the scope of the work. We read about magnetism, primary batteries, electric bells, and kinema sets. We also read about three-core cables, rotary converters, boosters, interpoles, etc. The book would have been more useful if the description and elementary theory of the more intricate apparatus had been excluded. It does not advance our technical knowledge of what is meant by "candle-power" to be told that "a source of light is said to possess candle-power." It is also not very instructive to be told that the back E.M.F. of a motor can be obtained by Fleming's right-hand rule. We failed to follow the theory given for the action of the balancers in a three-wire system of distribution (p. 246). The reader ought to be told why the difference of pressure between the two ends of a circuit is called the "potential difference." The introduction of the word "potential" must strike him as mysterious. In electrical science, more almost than in any other, it is impossible to be perfectly exact "at once," but a beginning at precision should be made early, even although the author should run the risk of being called "academic."

The Nomenclature of Petrology: With References to Selected Literature. By Dr. Arthur Holmes. Pp. v+284. (London: Thomas Murby and Co., 1920.) Price 12*s.* 6*d.* net.

THERE is probably no department of science in which the nomenclature is in such a state of confusion as in petrology. The rocks that form the earth's crust include an innumerable variety of types which pass by imperceptible degrees into one another, so it is not surprising that rock names have been multiplied to an extraordinary degree, and that there has been considerable variation in their application. The student of petrological literature, therefore, frequently finds himself faced with unfamiliar terms or those which are used in a sense different from that with which he is acquainted, and he will owe a debt of gratitude to Dr. Holmes for the labour expended in compiling this invaluable work of reference. He will no longer be dismayed when he meets in the pages of geological publications with "lavialites," "ledmorites," "leeuwfonteinites," and "leidleites," all of which are explained in a single page. The book deals not only with the names of rock types, but also with those indicating their structures and other characters, and we shall know now what is meant when a rock is referred to as being "lepidoblastic" or "glomeroplasmatic."

A useful feature is a list of the commoner prefixes and suffixes and the meanings usually attached to them by petrologists, and there is a glossary of French and German terms. A tabular classification of rocks, including ore deposits, follows, and presents many novel and interesting features. It is based partly on fundamental principles of rock genesis, and so far it is likely to hold its own in the future; and partly on arbitrary numerical criteria, and must to that extent be considered only a provisional stage in the evolution of a scientific classification. There is an instructive synopsis of processes of alteration due to igneous exudations, and of their products; and the classification of metamorphic rocks according to their structure into maculose, schistose, gneissose, and granulose appears to be distinctly useful.

J. W. E.

Liquid Air and the Liquefaction of Gases. By Dr. T. O'Conor Sloane. Third edition, revised and much enlarged. Pp. 394. (London: Constable and Co., Ltd., 1920.) Price 21*s.*

IT must be confessed that the *raison d'être* of this book is not easy to discover. From its sub-title ("A Practical Work," etc.)—and, we may remark, from its price—one might expect an authoritative book of reference for the engineer. It is, however, intended as a popular exposition of the history of the liquefaction of gases.

An introduction to the elementary facts of physics is followed by a series of chapters on the personalities, methods, and apparatus of some leading experimenters, beginning with the work of Faraday, and culminating in the achievements of Mr. Charles E. Tripler. An outline is given of the Linde, Hampson, and Claude processes. Numerous experiments, such as that of pouring liquid air on the floor, or boiling it on a block of ice, are described and illustrated. Indications are given of some applications of liquid air.

The author has evidently read with care much of the historical literature, and his digests of some of the early work are well told. He would probably not lay claim to a first-hand acquaintance with the scientific and industrial cryogenic developments of the twenty years which have elapsed since the book was first written; and it may be doubted whether the information imparted is of a kind to satisfy any but the most superficially minded of readers.

George Stephenson. By Ruth Maxwell. (Heroes of All Time.) Pp. 192. (London: George G. Harrap and Co., Ltd., 1920.) Price 3*s.* 6*d.* net.

AN account is given in this book of the more important events which marked the career of George Stephenson. A few pages are devoted to a brief account of his childhood and early struggles. Then comes an account of the invention of the "Geordie" safety lamp for use in mines, which was brought out simultaneously with Sir Humphry Davy's famous lamp. The remainder of the book records in detail the more interesting points in the history of the great engineer from the time when he built the Stockton and Darlington Railway onward, and it is amusing to read of the struggles he had from time to time to secure the requisite Parliamentary authority for building railways on which traffic would travel at ten miles an hour! Nine excellent full-page illustrations showing some features of British railways in Stephenson's time make an agreeable addition to an interesting book.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Heredity.

MAY I bring the following considerations before readers of NATURE interested in the study of heredity and evolution? I daresay I am wrong, but I should be glad to learn just how I am wrong.

The multicellular individual springs from a germ-cell. Presumably he inherits solely through that cell. In the germ are none of the characters which he afterwards develops—limbs, scars, instincts, knowledge, and the like. These are characters not of a cell, but of a cell-community—the soma. The germ contains nothing but potentialities (powers, capacities, diatheses, tendencies) for producing in its massed cell-descendants these communal characters in response to fitting influences (stimuli)—food, internal secretions, heat, light, moisture, functional activity (use), injury, and the like. Strictly speaking, therefore, nothing is inherited save potentialities—powers to develop in this way and that in response to this and that stimulus. Lacking the right influences, an individual may not reproduce all that he inherits, but he can reproduce nothing that he did not inherit. Reproduction is inheritance *plus* development. In the case of variations development occurs without inheritance; the individual does not then reproduce; he merely produces. Such colloquialisms as "The son has inherited his father's muscles" do no harm so long as the real truth be borne in mind; but if the truth be forgotten, endless loose thinking, confusion, and futile discussion may result, and often has resulted, as we shall see presently. Problems concerning potentialities are, of course, matters for the student of heredity. Problems concerning reproduction (as to what influences cause development) are equally, of course, matters not for the student of heredity, but for the student of physiology.

The sum of the potentialities in the germ whence the individual springs is his nature; the sum of the influences which play on him and cause, or prevent, or change his development is his nurture. Both nature and nurture are necessary and equal factors in the development of all characters. The query as to whether nature or nurture is the stronger is akin to a query as to whether the steam or the engine is the more potent in moving the train. Nature and nurture are never warring, but always co-operating, factors.

Individuals differ by nature and by nurture. They vary, and then their differences are *innate* or *germinal*. They are modified, and then their differences are *acquired* or *somatic*. Obviously, the words in italics are used intelligibly when employed to describe likenesses and differences between *individuals*. Thus we know what is meant when we are told that one man is by nature or by nurture darker than another. But, obviously again, they are used incorrectly and unintelligibly when employed to describe likenesses and differences between characters. How, for example, is a head more innate and germinal and less acquired and somatic than a scar? Can anyone tell us in precise language? The scar is as much founded on germinal potentiality as is the head; the head is as much a product of nurture and as much situated in the soma as is the scar. Evolution has so fashioned the race whence the individual sprang (has conferred on it such a nature) that, given a certain kind of nurture, he produces a head, and given another kind of nurture, he produces a scar. Plainly, all characters are both innate and acquired, germinal and somatic, in precisely the same sense and degree. Plainly, also, inheritance (*e.g.* of latent ancestral traits) is one thing, while reproduction is another and quite a different thing.

Of course, we may, if we please, give arbitrary, limited, unusual meanings to our words. But we shall then, with the multiplicity of meanings, risk confused thinking. As Bacon said, "Men believe that their reason rules over words; but it is also the case that words react, and in their turn use their influence on the intellect." Thus we may limit the terms "acquired" and "somatic" to those characters which develop in response to use and injury, while reserving the terms "innate" and "germinal" for all other characters. This, indeed, is commonly done. Thus the abnormal musculature of the blacksmith is termed "acquired," while the normal development of the ordinary man is supposed to be innate. But the result is confusion worse confounded, for the muscles of the ordinary man also develop from birth forwards in response to use. Like most human structures, unused muscles, even in childhood, do not develop; they atrophy; they owe not only their development, but even their maintenance to use. If, then, we give these meanings to our words, we must apply the term "acquired" to vastly more than we do now, and we must go back to the infant, or beyond him, to find the natural man. Or, again, the word "innate" may be limited to the "normal," and "acquired" to the "uncommon." In that case we should have to term variations "acquirements," and call the English language germinal in England and acquired in France. In fact, no matter what arbitrary meanings we take, the moment we embark on them we are swamped in a sea of confusion.

Darwin founded his theory of natural selection on the supposition that innate likenesses and differences between individuals were transmissible. However he expressed himself at times, his meaning was usually clear. Lamarck founded his theory on the supposition that acquired likenesses and differences between individuals were transmissible; but he expressed himself in terms of characters, and his meaning, as we shall see immediately, was never clear. Gradually, especially after the advent of Weismann, discussion centred more and more on characters, some of which were termed "germinal" and others "somatic." At present most biologists hold that "acquired characters are not transmissible." But here again, can anyone explain precisely what he means? So far as I am able to judge, that pronouncement is neither true nor untrue; it is purely nonsensical.

Consider the following, which I think most biologists will consider true, and, I suppose, all will consider intelligible: "Heads, being germinal characters, are inheritable; but scars, being somatic, not germinal, are not inheritable." But since only potentialities are present in the germ, all we can mean by the statement that heads are transmissible is that offspring, inheriting like natures from their progenitors, reproduce, under like conditions, like heads. If we gave our words the same meanings, we should say that a scar is inherited when a child reproduces it under the same conditions as the parent did (*i.e.* in response to the nurture of injury). The child would then be like, both by nature and by nurture, to the parent. But no biologist regards a scar so reproduced as inherited. It would be regarded as inherited only if the child reproduced it in a way in which the parent did not, and could not, have produced it, *i.e.* only if the child became profoundly different by nature from the parent, *only if it varied.* It follows that the word "inherit" (because often used as synonymous with "reproduce") is employed, commonly but quite unconsciously, with two directly opposite meanings. When applied to "germinal" characters it is given its ordinary meaning; it then means *inherit* (in the only sense in which anything can be said to be inherited). When applied to "acquired" characters it means *vary.* All this loose use and misuse of words—innate, germinal, acquired, somatic, inherit, reproduce—is a legacy from the days, before the discovery of cells, when students of heredity thought in terms, not of the germ-tract, but of the whole individual, the soma. "Germinal" and "somatic" are modern terms, but they reproduce ancient, inaccurate, popular ideas. The result has been half a century of futile labour, discussion, and confusion. If it be thought that I am mistaken as to all this, can anyone tell us in precise terms what in the world the Lamarckian controversy was *about*; or what is meant when it is said that some characters have "representatives in the germ-plasm" while others are merely due to "light, heat, moisture, and the like"; or what is intended when an inquirer seeks to ascertain to what categories (germinal or somatic) certain characters belong, and so on?

Is not the following universally and indisputably true? Does it not cover the whole Neo-Darwinian-Lamarckian field, and much besides? *The sole antecedent of non-inheritance is variation. Apart from variation, like exactly begets like when parent and child develop under like conditions.* But if this general statement be true, the study of heredity is relatively simple. Its difficulties have resulted not so much from the complexities and obscurities of reality as from those of language.

The natural inference from the discovery of cells and their mode of origin is that heritage travels down the germ-tract. The *necessary* inference from this, in turn, is that all the characters of the individual are innate, acquired, and inheritable in exactly the same sense and degree. The inference which Weismann, hypnotised by words, drew was that acquired characters are not transmissible. If we give our words their natural meanings (which is not the meaning the Lamarckians gave), there is sense in the statement that acquired characters are transmissible. *Of course,* acquired characters are transmissible in exactly the same sense and degree that any characters are transmissible. But there is absolutely no meaning in the Neo-Darwinian statement that acquired characters are not transmissible. It is like a declaration that five miles weigh five pounds.

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Squalodont Remains from the Tertiary Strata of Tasmania.

During a recent visit to the north-west coast of Tasmania I was fortunate enough to discover in the Tertiary beds at Wynyard—usually regarded as Miocene—the skull and a good proportion of the skeleton of a Squalodont whale. The fossil is in a particularly good state of perservation, and has been removed to the biological department of the University of Tasmania.

The remains so far discovered in Australia which can be assigned definitely either to the Archæoceti or to the primitive Odontoceti comprise in all some six or seven teeth, so that the present discovery is of more than passing interest. A detailed description of this specimen will be published later, but I have thought that a preliminary notice might be of interest to British naturalists.

The following is a short summary of the characters of the skull of this fossil:

Measurements.—Total length, 56 cm.; zygomatic breadth, 37·6 cm.; snout length (from bottom of antorbital notch), 25·5 cm. Whole skull, dolphin-like; snout shorter in proportion to skull than in Squalodon, longer than in Prosqualodon or Patriocetus; shape of snout triangular, but slightly concave on each side. Nasal bones similar to those of Prosqualodon. External nares not so far back as in Squalodon. Supra-orbital plate of frontal not entirely covered by the supra-orbital process of the maxilla. Supra-occipital strongly developed, meeting frontals anteriorly, and so preventing the parietals from entering into the formation of the skull-roof. Symphysis

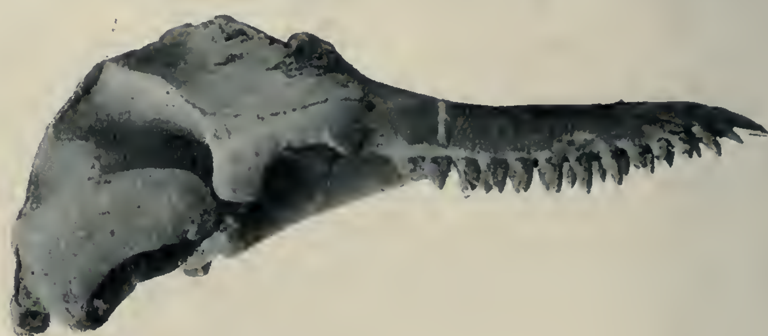

Fig. 1.

of mandible extends to posterior edge of first molar.

Dental formula: I 3/3, C 1/1, P 4/4, M 6/6 (Van Beneden's notation).

Posterior molar in each jaw degenerate. All molars two-rooted, with indications of disappearing third root. Roots of molars connected by an isthmus as in Prosqualodon; roots of premolars coalesced, though separated by a groove in some cases. All teeth closely packed in jaw, sometimes overlapping. Molars with three cusps on each edge, making, with the primary cusp, seven cusps in all. Pattern of surface of molar teeth can be seen from Fig. 2, (B) and (C).

The arrangement of the bones of the skull-roof marks this skull as being that of a Squalodont, but there are features in which the specimen closely approaches the Archæoceti, *e.g.* in the form of nasals, the position of the external nares, and the shortness of the rostrum. The problems centring round the dentition need not be discussed here.

It is possible that these remains might be referred to one of the genera Parasqualodon and Metasqualodon founded by Hall on an examination of the Australian teeth referred to above.

This is a point on which a definite opinion can be given only after a detailed examination of the teeth in the National Museum, Melbourne. I have refrained, therefore, from referring the specimen to any genus.

With regard to the figures accompanying this letter, Fig. 1 shows the skull from the right side, and Fig. 2 (A) the posterior premolar, (B) the fourth molar, and (C) the posterior molar, all of the left ramus of the mandible. In (B) and (C) can be seen the isthmus joining the roots of the molars and the traces of the original third root. The peculiar cusp-like pattern on the face of the teeth is also well shown.

It should be mentioned that the knob which is apparent in front of the nasal region of the skull in Fig. 1 is merely a concretion difficult to remove without damage to the skull.

Fig. 2.

T. Thomson Flynn,
Ralston Professor of Biology.
University of Tasmania, Hobart, September 9.

The Energy of Cyclones.

I do not find that people in general are aware of an important source of energy for the maintenance and intensification of cyclones, nor am I acquainted with a clear exposition by a meteorologist that the condensation of aqueous vapour will suffice.

Atmospheric pressure being a ton weight per square foot, the disappearance or collapse of a cubic foot of ordinary air would yield a foot-ton of work. The disappearance, by complete condensation, of the aqueous vapour in 760/12·7, say 60, cubic feet of atmosphere would yield the same amount.

If, then, the temperature of saturated air fell from 18° to 12° C. by reason of condensation and rainfall, so that the vapour-pressure diminished from 15·36 to 10·46 mm. of mercury, a foot-ton would be generated in each 155 cubic feet of that region of the atmosphere. Incidentally, the corresponding deposit of liquid would be 5 grams per cubic metre, or a rainfall of $\frac{1}{5}$ in. from a vertical mile of air.

Assuming that the above fall of temperature in the central region of a travelling cyclone is not excessive, the energy available in each cubic mile of it would be nearly a thousand million foot-tons.

Oliver Lodge.

With reference to Mr. R. M. Deeley's letter on the above subject in Nature of November 11, may I suggest that the energy of a cyclone is derived from the heat-energy of the earth's surface? If we assume that the air which ascends in the centre of the vortex is less dense on the whole than the air which is at the same temperature outside the vortex, then, since the ascending current must be compensated by a descending current elsewhere, the air will go through a thermodynamic cycle in which positive work will be done at the expense of the heat communicated at the earth's surface.

The process may be compared roughly to a Carnot's cycle, in which the inflowing air at the earth's surface is isothermally raised in temperature, expands adiabatically as it ascends, cools isothermally by radiation at the higher levels as it flows outwards, and contracts adiabatically in descending again. The work done would appear as increased vortical motion if the conditions were favourable, and the mechanical forces causing the motion would be due to the differences of hydrostatic pressure within and without the cyclone.

J. R. Cotter.
Trinity College, Dublin, November 13.

Molecular and Cosmical Magnetism.

Recent researches on magnetism tend to suggest that the negative electron may be a magneton or unitary electromagnet as well as a unitary electric charge, consisting, that is, of an anchor-ring of negative electricity in rotation about its axis of symmetry. Such a magneton would behave mechanically like a gyroscope; magneto-gyroscopic effects have been previously considered and observed in relation to ferromagnetic bodies on the assumption that the ferromagnetism is due to electrons in orbital motion as a whole. Wider conclusions can be drawn, however, if the magneton hypothesis is adopted, and the deductions are of importance, not only in the theory of atomic and crystal structure, but also in relation to cosmical magnetism. The following notes describe a few of the more important consequences; a detailed account of the theory and of some experiments designed to test its validity will be published shortly.

A magneton rotating with any kind of matter will tend to align its axis parallel with the axis of rotation. Since the electricity of the magneton is negative, the direction of magnetisation will be related to that of rotation, as is the direction of translation to that of rotation in a left-handed screw. This is the right direction in order to account for the general magnetic fields of the earth and sun as due simply to their rotation. The explanation of the observed magnitudes of these fields seems to present no difficulty; numerical details will be given in the forthcoming paper, where also a theory will be suggested to account for the rapid radial diminution of intensity in the sun's general magnetic field.

Mr. S. J. Barnett has shown by delicate experiments on ferro-magnetic bodies that they become magnetised slightly on being rapidly rotated, and has propounded a theory according to which such bodies should acquire magnetisation of amount proportional to the angular velocity, the factor being a universal constant depending on the ratio (mass/charge) for an electron. The fields observed and calculated (on this theory) agree as to order of magnitude, but are quite inadequate to account for solar and terrestrial magnetism. The theory, however, apart from the fact that it is based on the hypothesis of electrons in orbital motion, seems to require serious modification.

On the present theory, magnetisation by rotation should be shown by dia- and para-magnetic bodies as well as by ferro-magnetic substances, and the intensity should be proportional to the angular velocity only when the substance is in such a state that the constraints exerted on the magneton by neighbouring nuclei and electrons are strictly elastic. In this case, moreover, the factor of proportionality will not be a universal constant, but will vary with the nature of the constraints, and in particular with temperature; in hot bodies the intensity of magnetisation should be greater than in cold ones. An extreme case is that in which the temperature is so high as to produce general dissociation of the electrons from the nuclei, as appears to occur in the interior of stars. Apart from the disturbance produced by collisions, the magnetons are then free to set their axes parallel to the axis of rotation, and a large proportion of them would seem to do this in certain cases (*vide infra*). The upper limit of magnetisation is reached when all the magnetons are set parallel to the axis; this limit can be calculated in some cases, it being possible to estimate the number of electrons in electrostatically neutral matter of given kind and density. Other things being equal, the maximum magnetisation will be proportional to the density and independent of the speed of rotation.

The magnetic fields of the earth and sun can thus be accounted for on the present theory because these bodies are at a high temperature (in the case of the earth this is so except for the parts near the surface); what has hitherto been an obstacle in framing theories of their magnetic fields is here regarded as probably the determining factor as regards magnitude.

The same explanation applies to sun-spots. These occur in pairs of opposite magnetic polarity, and it has been pointed out that the polarities are such as would be accounted for by negative electricity in rotatory motion such as is observed (with opposite directions) in the members of a sun-spot pair. The sun-spot pair is thus regarded as the surface portion of a "line"-vortex continuously connecting the ends beneath the surface. The difficulty has been that no Stark effect is observable, such as would accompany rotating charges of the required amount; it has therefore been suggested that the magnetism of sun-spots is due to galvanic currents, *i.e.* electrons in translatory motion through electrostatically neutral matter. This hypothesis is unnecessary; it seems possible to account for the observed fields, of order 3000 gauss, simply by the observed rotation of the matter composing the vortex, on the above magneton hypothesis.

The obliquity of the magnetic axes of the earth and sun requires some additional hypothesis for its explanation, since an unsymmetrical condition cannot be accounted for by a cause, like rotation, symmetrical about an axis. The obliquity being present, however, it seems possible to explain the secular variations of the solar and terrestrial magnetic fields as due to precessional motion of the magnetons. A magnetic field applied obliquely to a magneton will tend to cause it to precess round the lines of external magnetic force. The magnetic fields of the earth and sun, due mainly to rotation, will exert this effect on any magnetons the axes of which are inclined to them; the speed of precession depends solely on the strength of the applied field if the magnetons are free, and the direction of precession agrees with the direction of rotation of the magnetic axes of the earth and sun.

S. CHAPMAN.

The University, Manchester, November 13.

Physiological Effects of Alcohol.

DURING recent years a good deal of work has been done and a great many results have been published on the above subject. Some of these have been very recently reported in the general Press. In most, if not in all, of the researches which have been made on the physiological effects of moderate doses of alcohol, taken in the form of beer, spirits, or other alcoholic beverages, but little attention has been paid to the very important disturbing influence of what may be called "secondary products"—whether extractive matters normal to the beverages in question or volatile by-products of the alcoholic fermentation process itself. Most people are aware that there is no *definite* relationship between the intoxicating effects of certain wines and the amounts of alcohol which they contain, and the marked difference in the physiological effects of new whisky on one hand, and of well-matured spirit *of the same alcoholic strength* on the other, is a matter of common experience.

In the case of beer the soporific effect depends not a little on the hop and other extractives, and consequently there is no scientific justification for drawing any definite conclusions of a quantitative character as to the physiological effects of small doses of alcohol unless the beer used in the whole series of experiments had been of precisely the same character throughout, and even then the "personal equation" would introduce a further serious difficulty. Most beer-drinkers of middle age are well aware that the physiological effects of bitter beer on one hand, and of mild ale or lager (which are less heavily hopped) on the other, are not by any means the same, even for equal percentages of alcohol. The investigation of the effects of these various "secondary" constituents undoubtedly presents great experimental difficulties, but until their physiological significance is better understood there must always be an element of uncertainty in any conclusions arrived at in regard to the physiological effects of small doses of alcohol taken in the form of the usual alcoholic beverages.

A. CHASTON CHAPMAN.

London, November 15.

Atomic Structure.

THE arrangement of the non-nuclear electrons in the atom is being determined by work along two lines: first, from the Bohr-Sommerfeld theory of characteristic frequencies, and, secondly, from the Lewis-Langmuir or Born-Lande theory of the structure of molecules, supported by Prof. W. L. Bragg's work on atomic radii in crystals. It has been stated several times recently that the conclusions drawn from the two sources are mutually inconsistent, in that the first indicates that the electrons are revolving in planetary orbits, and the second that they are fixed in constant positions. The essential truth of the first theory is now beyond doubt; the second is extremely plausible. If they are really inconsistent the position would be intolerable.

But they are not really inconsistent. The Bohr-Sommerfeld theory does not make explicit use of the assumption that the electrons in their stable states are moving; it assumes only that in those states they have the energy, calculated by Hamiltonian (relativity) dynamics, which they would have if they were moving in certain orbits. It is not logically impossible to maintain that they have that energy and are yet at rest. Nor is it physically impossible if we accept Bohr's principle of "correspondence," which has been so astoundingly successful in explaining the Stark effect and in predicting the number of components in lines of the hydrogen and helium spectra. According to that principle, the intensity and polarisation of components can be predicted by the application of classical dynamics to certain assumed orbits, although it must be assumed at the same time that the electrons are *not* moving in those orbits. If intensity and polarisation can be predicted from orbits that are wholly fictitious, why not energy?

Of course, the adoption of Bohr's principle in this extreme form would sever the last connection between classical dynamics and the real structure of the atom. But we are surely now all convinced that we must abandon part of that connection. Is there any reason but mere conservatism that makes us hesitate to abandon all of it, and to admit that, even in respect of energy, a fixed electron can have the properties which classical dynamics attributes to a moving electron? Classical dynamics, it is clear, is only "statistical"; what are the principles of the elements of the statistical group is the main problem of the physics of the future. NORMAN R. CAMPBELL.

November 16.

The Testing of Balloon Fabrics.

ON p. 130 of the Report of the National Physical Laboratory for 1919 reference is made to the testing and experimental work carried out in connection with the manufacture of balloon fabrics for war purposes, and in connection with this we wish to place on record this company's work in the manufacture of materials, especially hydrogen-proof fabric, for lighter-than-air craft.

The North British Rubber Co., Ltd., first took up the manufacture of this material in 1908, and, realising that the problems involved in manufacture necessitated scientific control, as a preliminary installed in its laboratory an apparatus for measuring the permeability of rubber to hydrogen, and thereafter initiated research into the factors responsible for the deterioration of rubber under the influence of light.

When the Admiralty installed its test station at Manchester we were requested by the officer in charge to furnish drawings of the special type of hydrogen diffusion apparatus which had been designed at Castle Mills, and one of its staff received a course of instruction in the company's laboratories on the procedure to be followed in testing balloon fabric. At a later period of the war this department was taken over by the newly formed War Office Aircraft Fabrics Department, which installed an extended testing plant, and another member of that staff also received his training in this work in our aeronautical laboratories.

The Aeronautical Inspection Department was also indebted to the laboratory of the North British Rubber Co., Ltd., for the training of some of its scientific staff, and its testing equipment was in many respects also based on the results of this experience.

During the course of the war our output was steadily increased, and at the armistice we were manufacturing more than 35,000 yards of balloon fabric per week, every piece of which was tested in our aeronautical laboratories for weight, strength, and hydrogen leakage.

The investigation of the research laboratory into the action of light on rubber resulted, moreover, amongst other things, in a discovery which, without any increase in weight, permitted the production of a fabric of vastly enhanced durability specially suitable for use in the tropical theatre of the war.

Our reason for asking for the publication of this communication is only for the purpose of stating that at least one manufacturer was sufficiently well equipped, not only in the manufacture, but also in their scientific staff and laboratories, to carry on without outside help, and it is not intended to detract in any way from the very useful and great assistance which the National Physical Laboratory gave to Government Departments and others starting out in what was probably new ground to them.

W. A. WILLIAMS,
Works Manager.

The North British Rubber Co., Ltd., Castle Mills, Edinburgh, November 12.

Luminosity by Attrition.

WITH reference to Sir Ray Lankester's suggestion in NATURE of November 4 that chemists should endeavour to ascertain the cause of the "empyreumatic" odour which accompanies the flashes of light produced by rubbing two quartz pebbles together, may I suggest also that the inquiry might be extended to include other substances which possess this property of triboluminescence?

The property is not confined to *crystallised* silica; it is displayed also by the amorphous varieties (opal, etc.) and by flint and chert.

Felspars possess the property in varying degrees; in general, it is more pronounced in the alkali felspars than in the lime-soda species. Fused albite displays the property.

Certain types of igneous rocks, both crystalline and glassy, behave in the same way. The property is most marked in the acid types; in the basic types (*e.g.* picrites, etc.) it is feeble or wanting.

Among the sedimentaries, sandstones, arkose, etc., and among the metamorphics, gneiss and some crystalline schists, display the property. The empyreumatic odour is a general accompaniment in the cases referred to above.

Saccharin and certain varieties of sugar possess the property in a moderate degree, and Dr. Lawson (Newcastle) has observed it in uranium nitrate when crystals of the salt are shaken up in a bottle.

I have investigated a large number of other substances (artificial glasses, rocks, and minerals); in the main, the results are negative.

Luminescence occurs between any pair of the "active" rock or mineral substances mentioned, and it would seem that the property is not dependent on crystallinity or wholly on chemical composition, but its relation to silica content (in silicates, etc.) is as yet obscure.

As regards the crystalline substances, the idea prevalent on the Continent is that during the process of crystallisation some of the outer electrons of the atom-system become detached, as it were, from the rest, but can recombine, with accompanying luminescence, under the stimulus of violent vibration. On the other hand, it may be a piezo-electric phenomenon; strain and deformation may induce positive and negative electrical charges on neighbouring particles, discharge being accompanied by luminescence. As the investigation is incomplete, further discussion would be out of place. A. BRAMMALL.

Imperial College of Science and Technology (Royal School of Mines), South Kensington, S.W.7, November 13.

Spiranthes autumnalis.

IN NATURE of September 16, p. 79, I reported the occurrence of this orchis, new to Scotland, in Lower Strathspey. As I can find no record of the species growing on soil other than cretaceous, and as there is no lime in the soil where I found the plants, I suspect that I may have been deceived by the superficial resemblance between Spiranthes and *Goodyera repens*. The point, of course, might have been decided at once by lifting a root; but, being very unwilling to disturb rare plants, I refrained from doing so. I hope to return to the place next summer to verify the species; until then I must ask botanists to dismiss my note as *non avenue*. If it should prove that I have erred, I have done so in good company, for was not Sir Joseph Hooker deceived by the decussate, scale-like leaves of *Veronica cupressoides* into pronouncing that plant to be coniferous from specimens sent from New Zealand? HERBERT MAXWELL.

Monreith.

Negro Life in South Central Africa.[1]

By SIR H. H. JOHNSTON, G.C.M.G., K.C.B.

THERE have been very few books like the two volumes before us published about any people of arrested development, even in Germany, where, before the war, a certain standard of perfection was reached in ethnological treatises. It is difficult to find any fault with the work, in regard to either what has been put in or what left out. The authors are the Rev. Edwin W. Smith, an honorary chaplain to the Forces and a Church of England missionary to the Ba-ila, and Capt. Andrew Murray Dale, a magistrate in the British South Africa Company's administration. Capt. Dale died (unhappily) last year of blackwater fever, worn out with much war service. The Rev. E. W. Smith, if I mistake not, saw considerable war service in Italy and elsewhere, and his work with the Forces kept this remarkable book back from publication for some little time. Incidentally, I might mention him as well known to students of Bantu. He was the author of a handbook of the Ila language, and an important contributor to the information on South-west African languages in my "Comparative Study of the Bantu."

The Ila people inhabit the central part of Northern Rhodesia, especially the region through which flows the great river Kafue. (This name seems to be a corrupted and abbreviated form of Kavuvu or Kafubwe, which means "Hippopotamus.") They have evidently been a conquering race of invaders from the north-east which has imposed its language and customs on less courageous tribes of inferior physique. The true Mu-ila is—for a pure Bantu negro—rather a handsome type, at any rate in beautifully formed and proportioned body and limbs; but other tribes speaking the Chila language to-day are of different stocks; some may even go back for their ancestry to Bushmen or to Congo pygmies, and in remembrance of this they are called "Batwa" (dwarfs) to this day. Others, again, belong to the Luba group, the men of which have almost an Arab cast of features and a full beard.

This most noteworthy work deals with the history, the physical characteristics, clothing (often lacking in the males), building operations, food, domestic animals (their cattle are straight-backed, and seem to have come to them from the west and south, the old Damara-Ngami breed and Portuguese), hunting, warfare, medicine, iron-work, pottery, social organisation, terms of relationship, religious beliefs, relations of the sexes, folk-lore—and what perhaps is most interesting and novel, their ideas about psychology, astronomy, biology, the undefined external forces of Nature, thaumaturgy, and therapeutics. The chapter on etiquette brings home to one how minutely these seemingly savage men and women may order their lives by prescribed custom, and what slaves they can be to convention. No newly enriched person in our own land, wishing to move

FIG. 1.—A Baluba type. From "The Ila-speaking Peoples of Northern Rhodesia."

[1] "The Ila-speaking Peoples of Northern Rhodesia." By the Rev. Edwin W. Smith and Capt. Andrew Murray Dale. In two vols. Vol. i., pp. xxvii+423; Vol. ii., pp. xiv+433. (London: Macmillan and Co., Ltd., 1920.) Price 50s. net two vols.

without attrition in the highest circles, need undergo such a tax on the memory as the stranger who would desire neither to offend nor to shock a Mu-ila man or woman. The language is full of pitfalls, because it is as rich in double meanings as any European tongue. You may be grossly indecent in alluding to common objects of the house or garden implements.

The Ba-ila are so sensual that the relations between the sexes are nearly promiscuous. Yet here again everything must be governed by custom. One man may be fined lightly for a gross act of immorality, while another will be mulcted severely for merely alluding to an indecent proposition. Many of the dances and a number of the songs—especially those sung at funeral ceremonies—are termed by the authors "phallic," and here very sensibly they quote the actual words and deeds, lest imagination should exaggerate. The authors conclude that this condition of immorality, especially among quite young people—children not fully mature—is leading to a seriously diminishing birth-rate.

FIG 2.—Young Ba-ila fresh from the hairdresser. From "The Ila-speaking Peoples of Northern Rhodesia."

In some writings on Africa missionary work is still sneered at; but one result—especially in South and East Africa—has been to raise the birth-rate amongst the negroes by discouraging polygamy, and, above all, by strenuously urging the abolition of the depraving initiation ceremonies and all immodest behaviour amongst young girls and boys. The worst feature in Ila-land is the abuse of quite young girl-children by adult men.

But the study of these primitive people as a whole leaves one with a very pleasant mental impression, alike of them and of their two interpreters, Mr. Smith and Capt. Dale. The absolute truth is told about them, but it is told so tersely, with so much humour, sympathy, and insight, that the discriminating reader, the ethnologist above all, rises from the reading of "The Ila-speaking Peoples" with a sense of gratitude to the authors and with a wonderfully vivid impression of negro life in South Central Africa—a life in that particular region very little influenced as yet by the white man. One hopes sincerely that the Ila people may turn the corner under wise administration and missionary teaching, and become in time a flourishing race, playing a considerable part in the development of Northern Zambezia.

Industrial Research Associations.

III.—THE BRITISH COTTON INDUSTRY RESEARCH ASSOCIATION.

By DR. A. W. CROSSLEY, C.M.G., F.R.S.

THIS association was incorporated in June, 1919, but much valuable work had been done previously by a Provisional Committee appointed by the Department of Scientific and Industrial Research towards the end of 1916. The Committee was presided over by Mr. J. W. McConnel, to whose efforts it is largely due that more than 90 per cent. of all the spinners, doublers, manufacturers, bleachers, dyers, calico printers, and finishers engaged in the cotton industry have given their support to the association, which now numbers 1461 members, including representatives of the lacemaking and hosiery trade. The first chairman of the association was

Mr. H. R. Armitage, of the Bradford Dyers' Association, who was most unfortunately compelled to resign owing to ill-health after a few months' activity. His place has been taken by Mr. Kenneth Lee, of the Tootal Broadhurst, Lee Co., Ltd. The council of the association is composed of men representing all sections of the industry, and is strengthened by the inclusion of some men of science and leaders of the following great operatives' organisations: the Amalgamated Association of Operative Cotton Spinners, the Card and Blowing Room and Ring Frame Operatives' Association, the Amalgamated Weavers' Association, and the Operative Bleachers', Dyers', and Finishers' Association.

In November, 1919, the council appointed the present writer, then Daniell professor of chemistry in King's College, University of London, director of research. He was unable to take up his full duties until April of the present year, and in the meantime plans for the future development of the association's activities were discussed. It was decided that individual scientific effort would not give the desired results, which could only be obtained by establishing an institute worthy of the great cotton industry, where all the sciences involved in that industry would be found represented and working in the closest co-operation. Apart, therefore, from the annual income of the association, the council has decided to raise a special building fund of 250,000*l*. A property with more than 13 acres of ground has been purchased in Didsbury, and the existing house adapted to serve as the administrative block, with accommodation for offices, library, council room, etc., as well as dining rooms, rest rooms, and some living rooms for the research workers. Owing to the housing difficulty, it has also been decided to build a certain number of houses in the grounds, where the first portion of the laboratories and workshops is also in course of construction. The whole will be known as the Shirley Institute.

The heads of the following departments have been appointed: Information and records bureau; botany; colloid chemistry and physics; general chemistry; organic chemistry; and physics; and, pending the completion of the new laboratories, accommodation has been placed at their disposal by the Manchester University and the College of Technology. The information and records bureau will have for its main object the acquiring of all information regarding cotton, which will be available for the members of the association. In addition, current literature will be abstracted and indexed, and reports on previous work on cotton will be prepared. This naturally means the gradual acquisition of an extensive library, and it is hoped that, in accordance with the suggestion contained in the Report on Libraries and Museums of the Adult Education Committee of the Ministry of Reconstruction (Cmd. 9237), this will become a central library organisation for the cotton industry.

The council has taken a very broad view regarding the nature of the research work to be undertaken, which is necessitated by the almost complete interdependence of the various sections of the industry. Work which will benefit one section must of necessity exert an influence on the whole industry. Hence, as shown by a programme of research drawn up by the research committee for the general guidance of the director and research staff, the work will be mainly of a fundamental nature. For the future development of the industry it must be left to science to find out more of the life-history and properties of the cotton fibre, and to carry out fundamental research into the chemical and physical changes introduced during manufacture, before the users of the fibre, in conjunction with the research staff, can make suggestions for the improvement of existing processes and machinery. For example, the study of the properties (botanical, chemical, and physical) of the single cotton fibre is fundamental to the whole industry. The fibre is of a complicated nature, consisting of differing chemical products enclosed in an outer skin or cuticle, and it is not known certainly whether some bleaching processes remove the cuticle, or how its presence or absence affects the feel, lustre, dyeing, and wearing properties of fabrics. The botanical side will also be concerned with the conditions of growth and breeding of the cotton plant, in so far as these affect the quality of the raw material, and it is hoped that this work will be carried out in the closest conjunction with the research department of the Empire Cotton Growing Committee.

The general purpose of research in cotton spinning will be to connect the properties of the raw cotton with those of the yarn it produces. Evenness of yarn is of importance to both the spinner and the weaver, but methods for improving this and other qualities demand in the first place accurate methods of testing them. During the exploration of this field precise information should be obtained as to the manner in which each existing machine carries out its various functions, and as to the effect of different properties of the raw cotton and of mixings thereof on these functions. Such measurements and information require the invention of special scientific instruments and methods for measuring the properties of raw cotton—*e.g.* length of staple, the diameter, strength, and elasticity of yarns and fabrics, and the effect of temperature and humidity on the spinning properties of the fibre.

The sizing problem is also one of great importance. It is not known, for example, why sizes prepared apparently in the same way should produce in some cases hard, and in others soft, warps, or what is the effect on the size of adding waxes, fats, and other substances, or how these affect the penetration of the threads, strength, and resistance to rubbing; nor is it possible in many cases to trace the cause of defective sizing to its ultimate chemical or physical source, or to predict from an analysis the exact sizing qualities of a given sample of material.

Many other problems could be alluded to—*e.g.* the effect of water and of steam at high and low pressures on the fibre, and the tendering of fibres and fabrics by acids, light, and heat—but sufficient have been mentioned to show that the whole industry bristles with scientific problems awaiting solution.

In attacking these problems it is certain that a vast amount of purely scientific work will have to be undertaken. The association is fully alive to the fact that pure research has in the past, in this country at all events, been almost the monopoly of the universities; but the scientific workers of our universities have not, generally speaking, been sufficiently in communion with industry fully to appreciate the nature of the problems in pure science which any particular industry required to be solved. The association hopes to keep in close touch with the universities, and that by so doing the ties between the scientific workers and industry may become closer in future. Certainly the association looks to the universities for much help as regards both the pure research work which will emanate from them, and the skilled research workers trained by them.

There is a further way in which relations with the universities may become more intimate, for, owing to the generosity of some of its members, the association possesses a number of scholarships tenable at any university, two of which have just been awarded; it also has the power to endow scholarships and bursaries for the training of persons engaged in studying the principles involved in any of the industries using cotton, or connected therewith, and four such scholarships are now held at universities, two being provided jointly with the Empire Cotton Growing Committee.

The relationship with pure science cannot, however, be strengthened by a policy of the purely "take and be thankful" type; something must be given in return; and it is hoped that science will be enriched by the publication of the pure scientific research carried out in the Shirley Institute. More particularly may this be the case in connection with the development of the department of colloid chemistry and physics, representing as it does a branch of science which has received comparatively little attention in this country.

Obituary.

LORD GLENCONNER.

BY the death, on Sunday, November 21, of Edward Priaulx Tennant, Baron Glenconner of Glen, the country has lost an appreciative friend of all good work, whether in the direction of art or of science, as well as a man of simple, lovable disposition and sterling character.

From his father, Sir Charles Tennant, the first baronet, Lord Glenconner inherited chemical works at Glasgow, to the business of which he attended; but his own tastes lay chiefly in the direction of forestry, natural history, and antiquarian pursuits. To study methods of forestry he had travelled in Germany and in many parts of the world, and his estates bear witness to the care bestowed on tree cultivation. It is well known that he purchased and gave Dryburgh Abbey to the nation a few years ago; and it is more than suspected that he had intended to do the same with Stonehenge had not another benefactor forestalled him. His house, which was characterised by admirable simplicity, was the resort of many distinguished persons, and his picture gallery was often thronged to hear about some discovery of scientific interest.

The loss of his exceptionally promising eldest son in the war was a profound grief to Lord Glenconner, from which perhaps he only half recovered; but he became convinced, and allowed himself to express publicly his conviction, of a reality underlying the old idea of human survival after bodily death.

REGINALD J. FARRER.

MR. REGINALD FARRER, whose death was reported in the *Times* of November 19, was an extraordinarily enthusiastic horticulturist, possessing, in a high degree, a poetic and artistic temperament, an experienced and intrepid traveller, and an accomplished and versatile writer. In horticultural circles he will be remembered as an ardent collector and cultivator of alpine plants, which he knew as few know them. He had studied them on many occasions in their native haunts, and had cultivated them under ideal conditions in his garden at Ingleborough. Many new plants, some of them of great interest and beauty, have been discovered and introduced by him into our gardens, enriching them, and at the same time making a valuable contribution to our knowledge of the flora of China and Tibet. As a geographer also Farrer will be known to many. The award of the Gill memorial medal of the Royal Geographical Society early this year was a recognition of the useful work he had done for geography in his journeys on the Chinese border of Tibet. His lectures before the society on these journeys were published in the *Geographical Journal*, vol. xlix., pp. 106–24, and vol. li., pp. 341–59.

Reginald John Farrer was a Yorkshireman, born forty years ago. At his home, near the beautiful Ingleborough Mountain, he had for many years made gardening, and especially rock gardening, a dominating interest. His natural rock garden is probably a unique example of such a garden in this country. In 1894, when a mere boy, he contributed to the *Journal of Botany* a note on the rare *Arenaria gothica*, which he had discovered in another station at Ingleborough some miles distant from that where alone it had previously been known in Britain. In 1898 he entered Balliol College, Oxford, as a commoner. Later he made several explorations in the European Alps with the special object of studying their vegetation. These explorations were described in several articles published in the *Gardeners' Chronicle* and in his book "Among the Hills," which appeared in 1911.

In 1903 Farrer undertook a journey round the world, visiting among other places Canada, China, and Japan. He visited Ceylon in 1907, and the years 1914 and 1915 were spent, in company with Mr. William Purdom, formerly of Kew, in exploring the Kansu region of Western China. "On the Eaves of the World," published in 1917, is a narrative of his wanderings and experiences during 1914, which were also the subject of a series of articles in the *Gardeners' Chronicle*. Last year another journey to Eastern Asia was undertaken with Mr. E. H. M. Cox. When about to return home, while travelling on the frontier range between Burma and China, Farrer fell a victim to diphtheria, and died on October 16.

Among the plants Farrer discovered were many new to botany as well as to horticulture. Several new species bear his name; he is also commemorated in Farreria, a new genus of Thymelæaceæ. In addition to works of fiction and those already specified, he wrote "My Rock Garden" (1907), "Alpines and Bog Plants" (1908), "In a Yorkshire Garden" (1909), "The Rock Garden" (Present-day Gardening Series), and "The English Rock Garden"; the last, containing more than 1000 pages and 102 plates, was published in 1919, and was reviewed, perhaps somewhat adversely, in NATURE for February 19 last, p. 664.

In spite of the extravagant, sometimes absurd, language of many of Farrer's writings, he accomplished much work of great value, and his untimely death is a distinct loss, which many will profoundly regret.

Notes.

THE Ministry of Agriculture and Fisheries has issued a memorandum (General Service, November 13) on the mode of spread of foot-and-mouth disease. The outbreaks which have occurred since the beginning of 1919 have enabled a closer analysis to be undertaken of the circumstances favouring infection than has hitherto been possible, the work being carried out by the Chief Veterinary Officer, Sir S. Stockman. One fact emerges as established, viz. that Great Britain, freed from the disease as endemic among animals in a particular district, is invaded only when the disease is prevalent on the Continent, particularly in the North of France, Belgium, and Holland. Livestock being excluded as a factor of spread of the disease, suspicion falls on human beings, on imported feeding-stuffs, and on litter coming from infected Continental districts. Importation of hay and straw, except for exceptional purposes, has, however, been prohibited since 1908 without materially influencing the occurrence of outbreaks. Carriage of infection by human beings and other means, *e.g.* by bird migration, seems equally improbable. The conclusion is drawn that the virus may be air-borne. The sick animals slobber, and it seems reasonable to suppose that the particles of infected mucus may be carried for long distances in the air, just as volcanic dust is. The outbreaks in this country are more frequent in some districts than in others, and it is suggested that in the areas mostly invaded air-pockets of negative pressure may exist which would account for the suspended virus descending to earth or water.

IN a lecture on "Eugenics and Religion," delivered on November 16 under the auspices of the Eugenics Education Society, Dean Inge pointed out that antagonism to reasonable eugenics, *e.g* the prevention of deaf-mutes and epileptics from having children, comes not from religion, but from the anti-scientific temper. A general revolt against the dictatorship of science (surely not yet even on the horizon) had been the most remarkable tendency in modern thought. But it seems to us it would have been more accurate to say that the objections even to considering the scientific control of life have come from a widespread sluggishness of intellect, an instinctive dislike of upsetting innovations, and, not infrequently among the elect, an other-worldliness which regards mundane conditions as a swamp to be crossed as quickly as possible. According to Dean Inge, the prospect for the immediate future is as black as it could be, and partly because society has not the seriousness and courage to replace a relaxed natural selection by a thought-out rational selection. At present we are breeding from our worst stocks, and our best are being squeezed out of existence—an extreme statement, probably too epigrammatically reported. But it has enough of truth in it to make us uncomfortable. We note, however, to take a glimpse of the other side, that, apart from the professional classes, many members of which are now prompted by economic pressure to restrict their family or to have none at all —which, as Dean Inge says, means a diminution of the well-born—there is an abundant supply of strong, intellectually alert, and good-willed men and women among working people. It appears to us to be historically true that a large proportion of the men who count have emerged, not from select castes, but from the general body of the population. Dean Inge attaches great importance to the post-war strain on professional men, which makes for restriction of the family, but this has been going on for a long time. He looks forward to a keen struggle for subsistence, which will force man to become a eugenist or to go under. Towards extreme struggle the nation is at present hurrying blindly.

THE chairman of the Colour Users' Association, Mr. Vernon Clay, has issued an important memorandum on the present position of the dye industry in Great Britain from the users' point of view. It is stated that the necessity for the establishment of dye-making factories is particularly a question of national security, because they are capable of maintaining a larger number of trained scientific workers than any other industry. At present the chief drawback with which the dye manufacturer has to contend is lack of experience in factory production, and while he is obtaining this knowledge some sort of protection must be afforded him. Three methods of safeguarding the infancy of the industry have been suggested. The first, by tariffs, is regarded as useless on account of the fluctuating rates of exchange; the second, by subsidy, is also ruled out owing to the difficulty of allocating a grant in an industry which has numerous by-products; and the third, by prohibition and licensing, is regarded as the only practicable scheme. Only dyes the home manufacture of which was inadequate in quantity or quality would be admitted under licence as imports. Under the Peace Treaty Germany must sell a proportion of her dyestuffs to this country until 1925 at rates similar to those which she obtains from other customers, so that the consumer is protected until that date. The manufacturer receives no benefit, and probably will require financial assistance to enable him to establish his industry. Assuming that after January, 1925, a licensing body were set up, the State, the dye makers, and the dye consumers should be represented on it; the last should have the preponderating voice because they will bear the brunt of the expense and inconvenience caused, and are the persons who can best gauge the effects on export trade, but the Government would retain the right of veto. The Government urges that this would place the power to defeat legislation in the hands of the consumers, and therefore negotiations between the association and the Government have proved unsatisfactory.

A DECISION which will be of interest to all scientific workers was given by Mr. Justice Eve in the Chancery Division of the High Court on Wednesday, November 17, on the motion for an injunction to prevent Messrs. Brunner, Mond, and Co. from distributing 100,000*l*., as it was authorised to do by an extraordinary general meeting on August 5. It will be remembered that at this meeting the directors were empowered to distribute that sum to such universities or other scientific institutions in the United Kingdom as they might select for the furtherance of scientific education and research. The money was to be provided from the investment surplus reserve account. It was urged that in carrying out the resolution the directors would be acting in a way which was outside the scope of the stated objects of the company, but Mr. Justice Eve ruled that the resolution came within the bounds of what was likely to lead to the direct advantage of the company, and therefore refused to make an order on the motion.

FROM time to time scanty information has reached this side of the Atlantic of developments in the use of "colloidal fuel," and experts have looked forward to receiving fuller information by which they could judge the value of the many claims put forward. Mr. Lindon W. Bates, with whom has been associated Mr. Haylett O'Neill, has been the pioneer of colloidal fuel, and these gentlemen read papers before the Institution of Petroleum Technologists on November 16 in which they put forward all that could possibly be claimed for this particular type of fuel. It was described as a stable, mobile, atomisable fuel displaying colloidal characteristics, comprising particles of solids, droplets of liquids, or minute bubbles of gas suspended in one or more varieties of liquid hydrocarbons. For commercial purposes it contains 25 to 40 per cent. of pulverised coal, which is held in stable suspension in oil, so that the product can be handled and fired with the usual oil-burning apparatus. The solid components may be coal, coke, charcoal, hard pitch, or any grindable carbonaceous substance, for the best results ground so fine that 97 per cent. will pass through a 100-mesh screen and at least 85 per cent. through a 200-mesh screen, and but little is stated to settle out in reasonable periods. The colloidal fuel is often volumetrically richer in heat units than the straight oil, and a saving of cost as compared with straight oil is shown, but this is far from holding as compared with powdered coal. In general, the efficiencies of oil and colloidal fuel are claimed to be substantially the same, and it is stated that there is some evidence that a surface combustion effect on the myriads of fine particles of solid is favourable to efficiency.

SIR FREDERIC KENYON has been elected a foreign associate, and Sir George Grierson a foreign correspondant, of the Paris Academy of Inscriptions and Belles Lettres.

BY the will of Mr. E. W. Smithson, who died on August 11, leaving estate of the value of 40,010*l*., the ultimate residue, after the death of his wife, is bequeathed to the Royal Society "for the furtherance of research in natural science, with a view of new laws or principles rather than the exploitation of what is known."

THE Cavendish Society, Cambridge, has decided to reinstitute its annual dinner, and has fixed the date this year for December 10. This dinner, with its post-prandial proceedings of topical physics songs, is a well-known function to former physics research workers at Cambridge. Information may be had from the Secretary, Cavendish Laboratory.

THE KING has given orders for the following appointments to the rank of Commander of the British Empire (C.B.E.), to be dated June 5, 1920:—Dr. A. C. Jordan, for work in connection with radiology at Queen Alexandra's Hospital; Mr. H. A. Madge, principal technical adviser on the wireless telegraphy staff of H.M. Signal School; and Dr. F. Mollwo Perkin, for valuable services rendered to various Departments of State.

THE Secretary of State for the Colonies has appointed a Committee to consider and report what steps can be taken to secure the assistance of the universities of this country in carrying out the research work which is essential to the protection of the inhabitants of the Colonies and Protectorates from disease and to the successful development of their veterinary, agricultural, and mineral resources. The members of the Committee are:—The Right Hon. Lord Chalmers (chairman), Sir H. Birchenough, Sir J. Rose Bradford, Sir W. Fletcher, Prof. E. B. Poulton, Sir D. Prain, Sir H. Read, Sir S. Stockman, and Sir A. Strahan. Mr. A. B. Acheson, Colonial Office, is the secretary of the Committee.

THE following have been elected members of council of the Röntgen Society for the ensuing year:—*President:* Dr. R. Knox. *Vice-Presidents:* Prof. A. W. Porter, Prof. J. W. Nicholson, and Dr. G. H. Rodman. *Hon. Secretaries:* Dr. R. W. A. Salmond, 51 Welbeck Street, W.1, and Dr. E. A. Owen, National Physical Laboratory, Teddington, Middlesex. *Hon. Treasurer:* Mr. Geoffrey Pearce. *Hon. Editor:* Major G. W. C. Kaye. *Other Members of Council:* Dr. J. Metcalfe, Mr. E. P. Cumberbatch, Dr. A. E. Barclay, Mr. F. J. Harlow, Dr. W. Makower, Mr. J. Russell Reynolds, Prof. A. O. Rankine, Mr. Cuthbert Andrews, Major C. E. S. Phillips, Dr. R. Morton, Sir A. Reid, and Mr. A. E. Dean. The names in the above list are in order of seniority.

THE Forestry Commission, in consultation with the India and Colonial Offices, has appointed an Inter-Departmental Committee to prepare a scheme for giving effect to the resolutions of the British Empire Forestry Conference with regard to a central institution for training forest officers, including (1) its location; (2) its organisation, constitution, and control; (3) its cost and method of financing; (4) its relation to forest research; and (5) the qualifications, selection, and cost of maintenance of students. The Committee consists of the following members:—Right Hon. Lord Clinton, representing the Forestry Commission (chairman); Mr. P. H. Clutterbuck, representing the India Office; Major R. D. Furse, representing the Colonial Office; Sir Ronald Munro-Ferguson; and Prof. J. B. Farmer. Mr. W. H. Guillebaud, Forestry Commission, 22 Grosvenor Gardens, S.W.1, will act as secretary to the Committee.

MR. L. H. DUDLEY BUXTON, of the department of human anatomy, University Museum, Oxford, has been invited by Dr. Zammit, of the Malta University, to conduct an investigation of the physical characters of the ancient and modern inhabitants of Malta. A party, consisting of Mr. Buxton, Mr. A. V. D. Hort, of Brasenose College, Mrs. Jenkinson, of Somerville College, Miss Moss and Miss Mond, of Lady Margaret Hall, under the leadership of Mr. Buxton, will visit the island for this purpose during the coming Christmas vacation. Archæological investigations will also be undertaken, but only in so far as these may be necessary to throw light upon the physical anthropology. The expedition has received the approval of the Governor of Malta, and the expenses will be met by a grant from the Mary Ewart Trust and by a generous donation of 100*l.* from Sir Alfred Mond. A report on the results of the expedition is to be presented at a meeting of the Royal Anthropological Institute to be held early in the spring.

THE Institute of Industrial Administration is holding a meeting at the Central Hall, Westminster, on December 7, at 7 p.m., when Mr. Richard Twelvetrees will read a paper on "Road Transport as an Aid to Industrial Management." The chair will be taken by Mr. E. Shrapnell-Smith, chairman of the Commercial Motor Users' Association, and the subject will be discussed from various aspects, including the development of roads, traffic congestion, handling of goods, and the design and maintenance of road motor vehicles. The lecture will be illustrated by kinematograph pictures, and various interesting models will be on view. Up to the present time the development of road transport has been largely regarded as the province of the engineers responsible for the manufacture of the actual vehicles employed, but it is expected that a much wider field of discussion will be opened by the lecture, which should be of scientific interest, and readers of NATURE are invited to attend.

THE Institute of Physics has now been incorporated and has begun to carry out its work. The object of the institute is to secure the recognition of the professional status of the physicist and to co-ordinate the work of all the societies interested in physical science or its applications. Five societies have already participated in this co-ordination, namely, the Physical Society of London, the Optical Society, the Faraday Society, the Royal Microscopical Society, and the Röntgen Society. The first president is Sir Richard Glazebrook, who will preside at the opening statutory meeting of the institute, which will be held early in the new year. The list of members now includes the names of more than two hundred fellows. Sir J. J. Thomson, the retiring president of the Royal Society, has accepted the invitation of the board to become the first, and at present the only, honorary fellow. It is a tribute to the status already acquired by the newly formed institute that its diploma is now being required from applicants for Government and other important positions requiring a knowledge of physics. Particulars with regard to the qualifications required for the different grades of membership can be obtained on application to the secretary, Mr. F. S. Spiers, 10 Essex Street, London, W.C.2. Fellows elected before May 1, 1921, will have the privilege of being styled founder fellows.

THE new premises of the London School of Tropical Medicine and the Hospital for Tropical Diseases, Endsleigh Gardens, N.W.1, were opened by the Duke of York on November 11. Lord Milner in an introductory address sketched the history of the school, which owed its inception to Sir Patrick Manson during the Colonial Secretaryship of Mr. Joseph Chamberlain, who welcomed and helped the scheme. Opened in 1899, the work of the school was carried on for twenty years in buildings at the Branch Hospital of the Seamen's Hospital Society, Royal Albert Dock. During the war it was found desirable to remove the school to a more central position in London. Through the generosity of the Red Cross Society 100,000*l.* was received for the purchase of the new buildings, and it became necessary to raise an additional sum of 150,000*l.* for the endowment of the school, of which more than 100,000*l.* had been collected. The Duke of York, in declaring the buildings open, paid a tribute to the successive Colonial Secretaries who had furthered the progress of tropical medicine, and unveiled a tablet recording the munificent gift of the British Red Cross Society and the Order of St. John of Jerusalem. One of the wards in the hospital has been endowed by the Mesopotamia Comforts Committee in recognition of the services of Sir Stanley Maude, to whose memory a mural tablet was unveiled. It is a pleasure to record that Sir Patrick Manson, the "father" of the school, was able to be present at the ceremony.

SIR CHARLES LYELL in his "Antiquity of Man" remarked that "neither need we despair of one day meeting with signs of man's existence in the Cromer Forest bed, or in the overlying deposits, on the ground of any uncongeniality of the climate or incongruity in the state of the animate creation with the well-being of our species." Mr. J. R. Moir in a paper republished from the Proceedings of the Prehistoric Society of East Anglia for 1919–20 (vol. iii., part ii.) describes a series of humanly fashioned flakes found in the cliffs and on the shore at Mundesley, Norfolk. Discoveries of similar flakes were made by Mr. Lewis Abbott in 1897 and by Dr. W. L. H. Duckworth in 1911. So far no human bones have been found in these strata, but the author notes that the Mauer Sand in which the famous Heidelberg mandible was found corresponds in date of formation with the Cromer Forest bed.

THE definition of the term "species" in biology is a perennial source of discussion. Dr. J. Massart considers that the Linnean definition—"the smallest assemblage of organisms that resemble one another more than they resemble others, and that transmit their peculiarities to their descendants"—corresponds neither to the Linnean species nor to the Jordanian species, but to the pure line of Johannsen. This last, however, need not be propagated by self-fertilisation, nor need the parents be homozygotes, for self-sterile and heterozygote lines are known. Dr. Massart illustrates his remarks by observations on the ilex, in a single grove of which tree he claims to have detected thirty-two distinct lines. Clearly, as he says, the systematist and the geographer must content themselves for the present with Linnean, or at the most with Jordanian, species. Dr. Massart's paper is published by the Belgian Academy (*Bull. Classe des Sciences*, 1920, pp. 366–81).

THE *Review of Applied Entomology*, now approaching the completion of its eighth volume, is a monthly publication of widely recognised value. For the modest sum of 18*s*. per annum one is enabled to keep abreast of all published work in the agricultural, medical, and veterinary aspects of the subject. Since the review was commenced an increasing number of articles in out-of-the-way periodicals have been abstracted, particularly those in the Russian and Spanish languages. It may be said that it is largely due to these abstracts that the work of Russian economic entomologists is being more widely known in this country and America. "Economic" entomology is interpreted in a liberal sense, and no very hard-and-fast line of demarcation is drawn between it and "scientific" entomology. For this reason the professedly scientific student should not neglect to peruse the pages of this valuable journal, for only by its means are many unfamiliar papers likely to be brought to his notice.

THE *Volta Review*, the Washington monthly devoted to speech-reading, speech, and hearing, is printing and issuing in the form of reprints a series of profusely illustrated articles on the mechanism of speech by Dr. E. W. Scripture, the author of the Carnegie Institution publication on "The Study of Speech Curves," of "Elements of Experimental Phonetics," and other related works. The series promises to be of great interest to students of phonetics, to those with normal hearing no less than to those who are handicapped in this respect. The voiced *h* of the Sanscrit grammarians is not quite such a novelty in Europe as would appear from p. 5 of the first article (July, 1920). Its existence in English was recognised by David Lyle in his "Art of Shorthand Improved" (1762), and its claims, though denied by Whitney and others, were fully admitted by Sweet.

AN address by Mme. Curie on the radio-elements and their applications appears in the *Revue Scientifique* for October 23. After reviewing succinctly the marvellous progress in the subject during the past two decades, and the current views to which the study of radio-active substances has led, reference is made to their applications for the manufacture of luminous compounds and in medicine. The first, though largely developed during the war, are obviously of application in innumerable ways for peaceful purposes wherever the cost of the radio-active materials is not prohibitive. In addition to the medical applications, such as for the treatment of lupus and arthritis, radium-therapy was during the war applied to the treatment of unhealthy scars and wounds, healing in numerous cases being assisted by irradiation. In spite of the slowness of the progress so far made, radium is regarded as a very powerful means of combating cancer, the number of deep cancers successfully treated steadily increasing. It is important that in all countries full use should be made of all resources in radio-active materials. As possible new sources the more active springs are referred to, one in Italy being mentioned which gives about 30 millicuries of emanation in 250 cubic metres of water daily. If this could be separated it would prove of great service in medicine. The proper utilisation of these resources would be facilitated by the establishment of central national institutions for pure researches in radioactivity in connection with an industrial laboratory for the treatment of large quantities of materials, and a section devoted to radium-therapy and its teaching. In conclusion, a strong plea for such an institute is made for France which shall be worthy of the country and its capital. Hitherto the requirements of medical men and physicists have been too exclusively considered.

IN the May and November issues of the Journal of the Royal Photographic Society Dr. W. H. Mills and Sir W. J. Pope publish the results of their work during the last few years on photographic sensitisers. In the first communication they describe the preparation and sensitising effect of twenty different *iso*cyanine derivatives, one of which, trimethyl*iso*cyanine iodide, is now well known as pinaverdol or sensitol green. They find that the total induced sensitiveness diminishes steadily as the molecular weight of the dye is increased by the introduction of heavier radicals, and they are able to draw other inferences that may prove useful guides in seeking for new sensitisers. Of these twenty derivatives, which include ethyl red and pinachrome, it appears that none is so generally advantageous as sensitol green. The second communication treats of the "carbocyanines," and describes the preparation and action of eighteen different derivatives. One of the diethylcarbocyanine iodides is pinacyanol or sensitol red, and it is found that the sensitising power for gelatino-silver bromide is far less in the dimethyl derivative, and that it sinks gradually on passing to the dipropyl and dibutyl compounds. In the *iso*cyanines the two quinoline residues are linked by the group :CH·, while the joining group in the carbocyanines becomes :CH·CH:CH·. The lengthening of this linking chain is accompanied by an extension of the extra sensitisation far into the red region of the spectrum, and the authors suggest that if methods were available for still further lengthening this chain it would be possible to produce compounds that would sensitise still further into the infra-red. Inferences are also drawn with regard to the effects of the positions of the substituting radicals and other matters.

THE Research Defence Society has lately published four pamphlets of general interest, namely: (1) Vaccination, by Dr. Mary Scharlieb; (2) The Prevention of Tetanus during the Great War by the Use of Antitetanic Serum, by Sir David Bruce; (3) The Work of the Medical Research Committee, by Sir Walter Fletcher; and (4) The Value of Experiments on Animals: Notes of Personal Experience, by Sir Leonard Rogers. The set, price 2*s*., may be obtained from the society's Secretary, 11 Chandos Street, Cavendish Square, London, W.1.

IT is eight years since the first edition of Prof. F. Soddy's volume, "The Interpretation of Radium," was published, and during that momentous period the necessity for enlarging and revising the original version has been proved. Mr. Murray announces that the author has been at work, and, with due compressions and the right additions, particularly those that bear upon the problem of the constitution of the atom, has brought the volume as closely up to date as is possible with a large and rapidly extending subject.

Our Astronomical Column.

LONGITUDE BY WIRELESS.—The scheme for linking up the observatories of the world by utilising wireless time-signals was referred to in NATURE for May 20 last (vol. cv., p. 370). It must be understood that no appreciable increase of accuracy over the older method by cable signalling is claimed; indeed, where the observers are not interchanged the precision is less. But the gain in convenience, expense, and wide distribution of signals is considerable, and it is known that where the travelling-wire method of observing transits is adopted, personality is greatly reduced; what remains is of the same order as the small local deflections of gravity, which can be eliminated only by extensive geodetical operations.

Mr. Dodwell, the director of Adelaide Observatory, has communicated the longitude which he deduces by the reception of the Lyons and Annapolis signals at Adelaide and Greenwich. It is 9h. 14m. 19·95s. using Lyons signals, and 19·78s. using Annapolis ones. The Nautical Almanac value is 20·30s. Allowance has been made for time of transmission, assuming a speed equal to that of light.

Many of the Australian boundaries are defined as meridians east of Greenwich by a specified number of degrees. They were determined by lunar observations and are known to be in error by some miles. It is not, however, expected that any change will now be made in them.

AN APPARENT EARTH-EFFECT ON THE DISTRIBUTION OF SOLAR FACULÆ.—The Monthly Notices for June contains a paper on this subject by Mr. E. W. Maunder, who acknowledges important help from several others in discussing the material, which consists of the Greenwich photographs from 1878 to 1916. The research was undertaken to test the result announced by Mrs. Maunder in 1907 that there was a preponderance of spots on the eastern half of the visible disc. Suggestions were made that this might arise from the spots sloping backwards or from the surface being heaped up behind the spot, thus avoiding the necessity of invoking an "earth-effect." The faculæ, however, since they are evidently above the surrounding surface, could scarcely be affected in either of these ways, so that an eastern preponderance seems very hard to interpret otherwise than as an earth-effect. Such a preponderance is, in fact, shown for the greater part of the period under discussion. The average excess for thirty years is about 3 per cent.—a quantity of the same order as that found by Mrs. Maunder for spots, and later for prominences. The northern and southern hemispheres of the sun are plotted, and show a general accordance, with differences of detail. There is fairly clear evidence that the eastern excess varies with the progress of the sun-spot cycle, being least marked during the increase of solar activity and most marked during its decline. In other words, regarding the earth-effect as a damping influence on the spot activity, then the solar resistance to this damping is greatest at the time of increasing activity.

THE DENSITIES OF BINARY STARS.—In a paper in *Mem. della Soc. degli Spett. Ital.* (vol. viii., Ott., Nov., Dic., 1919) Dr. G. Abetti discusses the densities of several binaries of which the relative masses and parallaxes are known. The diameters are inferred from the absolute magnitude, and surface brightness is inferred from the spectrum. The extreme values of density are 0·002 for ϵ Hydræ A and 1·87 for ϵ Hydræ B. On plotting the mean densities as functions of spectral type, there is a slow but steady decline from 0·60 for A5 and 0·55 for F5 to 0·45 for G0 and 0·2 for K0. This agrees with Prof. H. N. Russell's hypothesis on the assumption that the stars in question are in the giant stage, passing from an early diffused condition (type K0) to one more condensed through the types G, F, and A. Plotting mass as a function of absolute magnitude, all masses above 1·5 have about the same absolute magnitude, while all the fainter absolute magnitudes have about the same mass, the mean for these being about 0·3. The number of stars discussed is too small to lay great stress on the results.

Science and Fisheries.[1]

By H. G. MAURICE, C.B.

I SHALL, without apology, introduce a controversial topic, and endeavour to maintain a view which I myself hold with conviction. That view, expressed in the simplest terms, is that scientific investigations of fisheries are primarily a matter for the State, and can, as a whole, be most successfully conducted by a Government Department charged with responsibility for fishery matters. I believe—and I may say that, in a general sense, it is the view of the Department of State I have the honour to represent—that a Department of Fisheries which does not conduct such investigations is, *ipso facto*, unfitted for the work it has to do and might as well cease to exist, and that in many respects the State is better placed for the purpose than a semi-private institution.

A Live Department of Fisheries Must do Scientific Work.

The function of a Fisheries Department is to promote progress in the industry. All development in the fisheries and in the trades allied to fisheries is dependent, in the long run, upon scientific investigations. A Department of Fisheries which is not adequately equipped for scientific research is, in my view, incapable of developmental work, and ought not to be kept in being at the public expense, because it certainly can do little good, and it may do a great deal of harm. If it is suggested that the Department can act on the reports of others, I say that that is not so. The Department must have a scientific intelligence of its own. In the ordinary course of events scarcely a day passes on which administrative officers have not occasion to seek information or advice of the scientific staff. Supposing that they could rely upon mere reference to scientific reports, the Department must have scientific officers to advise it on the bearings of those reports upon its work, and you can imagine what kind of a scientific staff it would be that existed merely for the perusal of reports and was cut off from every prospect of active scientific work and individual research.

There are many things which a properly equipped Department may do for the maintenance and development of the British fisheries, but there is practically nothing it can do effectively—and it is almost certain that it will do a great deal of mischief—if it has not a thoroughly competent, well-equipped, and earnest scientific staff actively engaged in scientific research. I say, therefore, that the Department of Fisheries *must* conduct scientific investigations.

Fishery Investigations can most Successfully be Conducted by the State.

(1) To begin with, for all practical investigations of the sea there must be a broad basis of statistics, and no person or institution can have the same facilities for the collection of statistics as a Government Department the authority of which is recognised in every fishing port. I have no doubt that if the Marine Biological Association sought statistics of the fish landed in the port of Plymouth, and, indeed, any neighbouring ports, it would get statistics of a sort gladly given in a friendly spirit. It would be difficult for it, however, to guarantee their accuracy, and if it asked for similar statistics at such distant ports as Grimsby, Hull, Fleetwood, etc., it would probably be refused, and the statistics would almost certainly not be accurate if given.

(2) The Department of Fisheries must be in close and constant touch with the fishing industry—that is to say, with the owners of fishing vessels, skippers, mates, and crews. It is, therefore, in a position to get assistance from them in various forms. One very valuable form of such assistance is the suggestions which fishermen themselves may offer, and which, even if wide of the mark, may, at any rate, be pregnant of ideas, as to what needs to be investigated, what lines investigations might usefully follow, or what is actually the cause of a hitherto unexplained phenomenon. Practical assistance can be given in the hospitality of their ships when engaged in commercial fishing. At the present time the Fisheries Department has fourteen fish measurers in its service, the majority of whom are working, by the courtesy of owners and skippers, on commercial fishing vessels. They take and measure all the fish in a definite number of hauls per day, with a view to the correlation of age, length, weight, and maturity, and with regard to the variations which occur corresponding to the differences in the nature of the bottom, position and season, and, to some extent, time. That work is particularly important now, because as regards at least three of the principal food-fishes we have the results of investigations which took place over a period of three years in the case of each fish before the war, and by the work which is being carried on we shall place ourselves in a position to compare the present condition of the stock of these fish in the sea with that of pre-war days, and thus be able to judge of the effect of the greatest measure of closure which has hitherto taken place. As one of the questions which we shall be bound to answer before long is whether in the interests of the conservation of that stock certain areas of the sea should be closed by international agreement to all fishing vessels, or to certain types of fishing vessel, permanently, or at certain times and seasons, it behoves us to make use of the great experiment which the war provided.

(3) Marine investigations on the scale which the preservation of our great fishing interests demands involve the use of deep-sea fishing vessels, which need to be kept in commission continuously throughout the year and from year to year, and they involve also the co-operation and assistance of other Government Departments concerned with shipping and with the sea, especially the Board of Trade and the Admiralty. The last-named Department in particular must of necessity carry out for its own purposes investigations which have a direct bearing upon our work, and, with certain necessary limitations, we can count upon its co-operation with us.

(4) The aim of our investigations, the only justification for them in the eyes of the State, which is calling upon the taxpayer to foot the bill, is the necessity of taking all practical steps to promote the development of the fishing industry, which, though the fact is not generally appreciated, undoubtedly saved this country from disaster in the late war. Moreover, the fishing industry brought into this country invaluable supplies of food; and even now we must, if we reflect, recognise the fact that fish is relatively cheap compared with other food, and, regarded as an import which does not involve any corresponding export, it is nationally by far the cheapest food the nation receives.

[1] Opening of a discussion on "The Need for the Scientific Investigation of Fisheries" in Section D (Zoology) of the British Association at Cardiff on August 26.

It behoves the State, therefore, to look well into the conservation of the stock upon which the prosperity of the industry depends; but it must be remembered that the bulk of the fish landed by our fishing vessels is taken in extra-territorial waters which are accessible to all nationalities alike. If, therefore, scientific investigations point to the necessity or desirability of regulations for the closure of certain areas of the sea or of such measures for the increase of the stock of fish or of the general bulk of the fisheries as transplantation or artificial propagation, it is essential that those measures should be adopted internationally in order that the good which one nation is endeavouring to do may not be undone by another nation which refuses to co-operate. If we are to have international regulations based upon the findings of science, those findings must be internationally accepted, and the simplest road to such general acceptance is co-operation in the work. Moreover, the area to be covered is so vast, the medium in which we are compelled to work is so obscure, the facts in the propagation and lives of fish which we are called upon to correlate are so many, and the study of most of them at the present time is so little advanced, that no one country working alone can hope to cover the whole field except at a prohibitive cost or at a rate which will leave the solution of the main problems to future generations. Therefore, combined international investigations are essential, and to none are they more important than to the greatest sea-fishing nation in the world. If we are to have such international co-operation, I maintain it must be co-operation between Governments.

The Scientific Aims of the Fisheries Department.

Whatever opinion may be held as to the capacity of a Department of the Government to conduct scientific research, at any rate it is something that a Government Department should be so firmly convinced of the importance of such research that it insists on carrying it out. The Ministry of Agriculture and Fisheries had before the war advocated and partly embarked upon a wide programme of investigation framed in consultation with an Advisory Committee of persons eminent in science. That programme was interrupted by the war. It included wholehearted co-operation with the International Council for the Exploration of the Sea in its general programme, and in the particular parts of it in which this country was more especially interested, and so much importance did the Ministry attach to these investigations and to the co-operation of our foreign colleagues that, alone of all the belligerent nations, Great Britain continued throughout the war to subscribe to the funds of the Council in order that the organisation which it represented might be kept in being to facilitate the revival of its work when conditions permitted. There is little doubt that, but for the financial and moral assistance of Great Britain, the International Council would have come to an end. I am convinced that the International Council will justify its existence; and it is interesting to observe that two new Powers, Spain and Portugal, have recently announced their intention of joining the organisation.

I have urged as a general thesis that the Department must carry out scientific investigations or run the risk of stultifying itself. I do not propose to discuss individual researches, but only to state the broad questions to which the Department seeks an answer. They are these:

(1) How can the stock of fish be maintained at its present level so that the prosperity of the fishermen may be preserved and the supply of food for the people not be diminished?

(2) Can the stock be increased by human endeavour while the fisheries continue to yield their present toll—or even an increased toll—to human necessity?

(3) Can we learn to foretell good and bad seasons for this or that fishery?

Having answered all or any of these questions, we must be prepared to answer as regards each one of them the further question:

(4) In what measure is the application of the findings of science practicable in existing circumstances?

I think those questions present with fair accuracy the positive aims of our investigations. I do not refer here to that other aspect of our work which concerns the utilisation of the fish when caught or to investigations affecting only inland and fresh-water fisheries; for the moment I am thinking only of what may properly be described as marine investigations. But these investigations, or rather the motive behind them, have also a negative aspect. The Department must always be prepared to resist what I may describe as panic proposals for legislation or proposals advanced by interested persons who use alleged facts of natural history as a stalking-horse. I need not particularise too closely. Most of you are aware of the outcry raised against the trawl on the ground that it damaged the eggs of fishes on so-called spawning-grounds, and how this allegation was disposed of by the discovery of science that the eggs of all the principal food-fishes of the sea, except the herring, were pelagic, and could not, therefore, be damaged by the trawl. That instance alone is sufficient to prove the importance to the Department, which may be called upon to introduce or to criticise legislative proposals for the regulation of fisheries, of having an adequate scientific intelligence.

The Relation of the Department to the Independent Scientific Worker.

These being the aims, broadly stated, of the Department, does it claim for itself the whole field of fisheries research, and does it seek to suppress independent effort? By no means. To me such a policy is inconceivable. Provided that the Department is itself supplied with funds for an adequate equipment in both apparatus and *personnel*, it must welcome the assistance of the independent worker, for the work to be done is so great and the field of research to be covered so vast that there cannot be too many workers in it.

Moreover, there is, I think, a perfectly clear and obvious distinction to be drawn between investigations proper to the State and those which are more properly confided to independent institutions. The State's business is to conduct investigations which are more or less expressly directed to the solution of clearly defined problems affecting the fishing industry, the demand for the solution of which either has arisen or can be foreseen. The function of the independent worker is to add to the sum of our knowledge without regard to the solution of any particular problem. The line must not be drawn too fine. On one hand, the Departmental staff must seek in the course of its inquiries all the knowledge it can get; and I, for one, hold that the Departmental scientific worker should, so far as is practicable, be given opportunities from time to time to take up and follow up a line of research of his own choosing in order that his vigour and freshness of mind may remain unimpaired. On the other hand, the independent institution or individual worker may properly be invited to take up a line of investigation which the Department foresees may be of importance, but has not the means or the time to prosecute itself. In short, the Department may see that such and such an institution or individual is admirably qualified for a particular piece of work, and may invite it or him to take it up at the Department's cost.

And so, while the Department maintains—and, in my view, must maintain—that fishery investigations are primarily its concern, and that it must have, so to speak, a first call upon State funds available for such research, its policy is to encourage every competent worker in the field; to procure adequate financial support for every institution which is giving its attention seriously to such researches and is so placed as to be in a position to prosecute them successfully; and to work in the closest and most cordial co-operation with them without seeking in any degree to limit their independence.

We are proud to represent the greatest fishing industry that the world has ever seen, and we are determined, if possible—and the possibility depends largely upon the measure of support we can secure from a nation amazingly ignorant of, and indifferent to, this all-important industry—to make Great Britain lead the world, not only in the practice of fishing, but also in the scientific studies upon which the future prosperity of the industry must depend. We have established close co-operation with our colleagues in Scotland and Ireland, and, I hope and believe, friendly relations with the scientific workers of those institutions which have established a reputation in this field of research and the continued prosperity and efficiency of which it is our hope to secure. And while we seek to lead the world, we seek also to secure the co-operation of the Governments of those other nations which exploit the harvest of the sea; for we have no monopoly of the fishing-grounds, though our position is most favourable for their exploitation, and whatever measures may be devised by science for the maintenance or increase of the harvest can be effective only if they are carried out by international consent, and wisely directed to the attainment of the object which forms the motto of the International Council: "The rational exploitation of the sea."

Scholarships and Free Places in Secondary Schools.[1]

AN interesting and important Departmental Report upon the above subject was published on October 25 by the Board of Education. The inquiry was begun a year ago at the instance of Mr. H. A. L. Fisher, President of the Board, and the Committee appointed was comprised of representatives of the Board, of the local education authorities, of persons engaged in elementary and secondary schools, and of others interested in the question. Some sixty-six individual witnesses were examined, including officers of the Board of Education and of local authorities, as well as teachers and others, representing in all thirty organisations wholly or partly concerned with education. The Committee was directed to inquire into the existing arrangements for the award by local authorities of scholarships tenable at secondary schools or institutions of higher education other than universities or institutions for the training of teachers, and into the provision of free places under the regulations of the Board of Education, and to make recommendations thereon with respect to the improvement of such arrangements so as to bring the facilities of higher education within the reach of all classes of the population and with special regard to the migration of pupils from one school area to another.

The report deals concisely with the history of scholarship provision at the instance of local authorities, and shows that the scholarships awarded by them tenable at secondary schools had risen from 2500 in 1895 to more than 12,000 in 1906, and if there be included those awarded to intending teachers, to more than 23,500. The next important step with the object of facilitating the transfer of suitable pupils from elementary to secondary schools was taken by the Board of Education in 1907, whereby, as a condition of qualifying for the higher rate of grant, secondary schools were required to admit a certain percentage of pupils (ordinarily 25 per cent. of the previous year's admissions) from public elementary schools, subject to an entrance test of proficiency. These were styled "free-place scholars."

The immediate effect of these regulations was to increase the number of pupils receiving free tuition in secondary schools, including those arranged for by local authorities, from 24 to 27 per cent. In 1911–12 the total number of pupils receiving free tuition in such schools had risen to 32 per cent., the actual figures being 52,583, of whom 49,130 had been in public elementary schools, and of this number 38,009 owed their exemption from fees to the scholarship and free-place arrangements of the local authorities. At the present time in 961 grant-aided secondary schools in England with some 246,000 pupils enrolled, the number of "free places" held amounts to 72,386, or about 30 per cent., made up of 53,460 awarded by local authorities, 16,548 by school governors, and 2378 by other endowments.

It is now the duty of the local authorities, made statutory by the Education Act of 1918, to make provision for the means of higher education for all children capable of profiting thereby. It is estimated on the basis of 20 per 1000 of the total population of England and Wales that there should be at least 720,000 duly qualified children in the secondary schools, or more than double the present number. The grave defect of the present system is, the report states, that exemption from fees alone does not, by reason of the poverty of many parents, enable their children to take advantage of the benefits of higher education, or if they do they are quite unable to keep them at school beyond fourteen years of age for the full period of secondary education. It is therefore recommended that maintenance allowances, including all incidental school charges, should be made available for all free-place pupils who are in need of them. Whilst favourable to the abolition of all fees in grant-aided secondary schools, the Committee scarcely considers the time ripe for so drastic a change, and therefore suggests as a tentative measure the raising of the percentage of free places from 25 to 40 per cent. of the admissions. The age of admission of free-place pupils should be between eleven and twelve, determined upon by an examination in English and arithmetic, followed by an oral examination. Free places should be awarded for the full school course, secured by agreement with the parents, and where a pupil migrates to another area he should be entitled to continue his education upon the same terms. It is recommended that children who have not been previously educated in public elementary schools shall be eligible as free-place pupils provided that the parents show inability to pay fees for higher education.

The report is signed by all the members of the Committee, subject to certain reservations on the part of a few members. It concludes with a valuable summary of statistics bearing upon various aspects of higher and specialised education.

1. Report of the Departmental Committee on Scholarships and Free Places. Pp. vi+82. (London: H.M. Stationery Office.) Price 9d. net.

Developments of Wireless Communication.

IN the course of his address to the Royal Society of Arts on November 17, Mr. A. A. Campbell Swinton, chairman of the council of the society, gave a remarkable experimental demonstration of some of the most recent developments in wireless telegraphy. Utilising only a small aerial on the roof, where the conditions were far from favourable, he commenced by picking up some messages of a general news nature which were being sent out by the 7000-metre continuous-wave station of the Admiralty at Horsea, near Portsmouth, about sixty miles from London. These messages were first received by means of a group of thermionic valves, and the clear-cut, distinct Morse signals were rendered audible to the large audience by a telephone receiver with a trumpet attachment.

A printing equipment of the pattern originally developed by Mr. F. G. Creed for line telegraphy, but now most successfully adapted to wireless working, was then put into action under the supervision of Mr. Creed himself, and the receiver was soon seen to be punching a paper strip in accordance with the Morse signals received. The strip was then put into the printer, and appeared on another strip automatically translated into ordinary type. A portion of the printed strip was projected upon the screen, and was seen to contain an extract from a speech by Mr. Bonar Law, with but few errors due to jamming or atmospherics. Between the experiments Mr. Campbell Swinton found time to explain briefly the way in which groups of thermionic valves connected in a particular way can be employed to detect and to amplify the received oscillations, and, by the addition of an auxiliary oscillation, to produce signals at a frequency audible in a telephone, by the method of beats. He also recapitulated the leading principles of the extraordinarily ingenious Creed receiving and printing instruments by which the signals are recorded in the Morse code and afterwards translated into ordinary type by means which we hope to deal with a little more fully later. The most impressive demonstration was the reception and printing of a special message sent from the Eiffel Tower by the kindness of Gen. Ferrié on the same apparatus, but with even more success than in the case of the Horsea messages.

Passing to wireless telephony, Mr. Campbell Swinton attributed the earliest accomplishment of real wireless telephonic communication to Prof. Poulsen, of Copenhagen, and showed diagrams of the latest arrangement used by the Royal Air Force. In conclusion, a special five-valve receiver, made for the purpose by Mr. H. W. Sullivan, was put into action, and the audience was entertained with some spoken remarks, whistling, and gramophone music from a short-wave installation in another part of London. Mr. Campbell Swinton predicts great developments in the field of wireless telephony, and looks forward to the time when a speaker at a political meeting will be able to make himself heard all over the world, or it will be possible for the King to address his subjects throughout his Empire simultaneously.

Engineering at the British Association.

SIXTEEN papers were read before Section G; these covered a wide field, but, with the exception of Prof. Howe's paper on radio-telegraphy, electrical engineering was entirely unrepresented. Several of the papers were of great importance in that they dealt with fundamental properties of materials and of internal-combustion phenomena. Prof. F. C. Lea read a paper on the effect of temperature on some of the properties of materials. Many materials, such as aluminium alloys, have highly desirable properties when cold, but undergo such changes at the temperatures met with in engine cylinders as to make them quite unsuitable. Fireproof buildings must be designed to have the requisite strength at temperatures likely to be experienced during a fire. The tensile strength and hardness of a large number of materials have been determined at various temperatures obtained by means of electric furnaces, details of which were given. In all the alloys tested the tensile strength and the hardness decrease as the temperature is raised, the decrease being very rapid between 200° and 400° C., which is a range likely to cover both the examples mentioned above. Concrete was among the materials tested on account of its importance in view of the behaviour of ferro-concrete buildings in case of fire.

Col. Crompton discussed the nature of the action leading to the blunting of the edges of cutting-tools. Without accurate knowledge of the nature of this phenomenon one cannot scientifically re-design cutting-tools when making them of the recently developed high-speed steels containing, in addition to carbon, such metals as tungsten, cobalt, molybdenum, nickel, and vanadium. These steels can be hardened like carbon steel, but, unlike it, they retain their hardness at the high temperatures caused by taking heavy cuts at high speed. They are also stronger to resist fracture, and can thus be made with a more acute angle. This angle varies from 90° in shears and punches down to 15° in the blades of safety razors. The smaller the angle the less is the force required to drive the edge into the material, but the weaker is the edge to resist breakage. If examined under a microscope the edge is seen to be blunted by the crumbling away of the material of which the tool is made. This crumbling is hastened by the shaving wearing a groove in the upper face of the tool, thus reducing the angle of the edge. The author was of opinion that all the ordinary tool angles could be reduced 25 per cent. when using high-speed steels.

It is not often that a paper is read before Section G by an author who speaks, not as an engineer, but as a critical user of the engineer's products. Mr. S. F. Edge's paper on farm tractors made one realise the importance of such communications. Mr. Edge evidently spoke from a wide experience of tractors of many types, and discussed them not only from the engineering and agricultural points of view, but also from that of their psychological effect on the labour question. He warned makers against sacrificing quality to cheapness, and expressed his belief in the future of the tractor industry if makers will give the farmers the best machines alike in design, material, and workmanship.

Mr. H. R. Ricardo's paper on a high-speed internal-combustion engine for research dealt with experiments carried out with an engine specially designed for fuel research at the request of the Asiatic Petroleum Co. Nothing had been spared to make the experiments trustworthy and exhaustive and of both scientific and commercial value. The author described the design and construction of the engine in detail, together with the arrangements for measuring the fuel supply, etc. With this engine one will be able to determine the efficiency of various fuels and the best conditions for the use of any fuel, and also to compare the performance with the calculated figures based on thermodynamic theory.

Prof. W. H. Watkinson described a dynamical method for raising gases to a high temperature without the use of high pressures, which consists in drawing the gas into a cylinder through a partly opened valve, so that the pressure in the cylinder is only a quarter, say, of that outside, and then compressing the gas up to the external pressure with consequent rise in temperature. By a cascade arrangement of several such pumps the temperature could be raised sufficiently high to ignite the gas in an internal-combustion engine.

Dr. C. Batho read a paper on the partition of the load in riveted joints, in which he explained that he treated the riveted joint as a statically indeterminate structure, and applied the principle of least work in order to determine the distribution of the load between the rivets. The details of the method have already been published in the Journal of the Franklin Institute (U.S.A.) for November, 1916. The author quoted some experimental results obtained with an extensometer which supported his theoretical treatment.

Prof. J. T. MacGregor-Morris described and demonstrated his portable direct-reading anemometer for the measurement of ventilation in coal-mines. This instrument, which is made by the Cambridge and Paul Instrument Co., consists of an ebonite handle carrying a cage containing four fine nickel wires, two of which are exposed and two shielded from the air. These wires form the four arms of a Wheatstone bridge, and the galvanometer is connected by means of a flexible wire passing through the ebonite handle. The galvanometer is first used as a voltmeter to adjust the applied voltage to the correct value for the observed temperature of the air. It is then used to indicate the out-of-balance bridge current, which depends upon, and is used as an indicator of, the velocity of the air-stream.

Messrs. H. T. Tizard and D. R. Pye read a paper on specific heat and dissociation in internal-combustion engines. Although very little advance has been made in recent years in the thermodynamical theory of internal-combustion engines, there have been great practical advances, and the actual efficiency of a modern high-speed engine is higher than the theoretical efficiency calculated on the old specific heat figures of Clerk and Lange. The temperature reached is about 2500° C., but the specific heats of the gases concerned were not known accurately above 1500° C., and the extent to which dissociation of CO_2 and H_2O takes place was also unknown. Data on these subjects are now available, having been obtained in Nernst's laboratory in Berlin. The authors apply these data to the engine and obtain results which are confirmed by experiment as regards variation of power and efficiency with strength of mixture, with compression ratio, and with different types of fuel. Closely allied with the foregoing was the paper by Sir J. B. Henderson and Prof. Hassé with the attractive title "The Indicator Diagram of a Gun." The diagram is not obtained experimentally, but by calculating the pressure from the temperature, which can be determined only when the specific heat and dissociation are known. The temperature of the explosion is of the order of 3140° C. absolute, and it is calculated that of the energy liberated from 92 to 95 per cent. is converted into kinetic energy in the projectile. A gun is a type of internal-combustion engine, and very similar difficulties arise in investigating the two problems.

A very important but difficult subject is the action in steam-nozzles, and a paper by Prof. A. L. Mellanby and Mr. W. Kerr recorded a great amount of careful experimental work carried out at the Glasgow Technical College, the data from which were analysed and discussed in the paper. Pneumatic elevators for the unloading of grain were invented in England, but, as in many other things, it was in Germany that later study and development took place. Prof. Cramp, who had studied Continental practice before the war and commenced a research on the factors determining the efficiency of such apparatus, was afterwards given a grant by the Department of Scientific and Industrial Research to enable him to continue the work. His paper gave an account of the experiments made by him at Manchester University. To design apparatus intelligently one must be able to calculate the weight of grain which can be lifted a given height through nozzles and pipes of a given shape and size by a given vacuum and a given power. Whereas mechanical elevators can be made to work with 75 per cent. efficiency, the pneumatic type cannot reach a higher theoretical value than 40 per cent., and in practice falls far short of this. In spite of this pneumatic elevators are used because of their labour-saving qualities and freedom from dust.

The most striking and imaginative paper read before the Section was that of Wing-Comdr. Cave-Brown-Cave on airships for slow-speed heavy transport and their application to civil engineering. The author discussed the use of airships with one or more trailing air-barges for the transport of men and material over virgin country through which a railway was being constructed or in which it was necessary to carry on prospecting. In his opinion the present stage of development of airships and of the methods of handling them is such that their use for such purposes is quite practicable and offers great advantages.

Prof. G. W. O. Howe discussed the efficiency of aerials and the power required for long-distance radiotelegraphy. Of the power supplied to an aerial, the fraction which is radiated decreases with increase of wave-length, but, on the other hand, the longer waves are transmitted around the earth with less attenuation than shorter ones. On the latter point, however, there are but scant empirical data; on the usually accepted assumptions the author calculated the power required to produce a given strength of electric field at various distances with different wave-lengths. Using the optimum wave-length in each case, the power required for a range of three or four thousand miles varies as the sixth to the eighth power of the distance. Prof. Howe mentioned that recent experiments between America and Italy indicated the necessity of much smaller powers than those given in the paper. In conclusion, the author pointed out the need for extended research on this subject to enable a network of stations to be designed intelligently.

In the concluding paper Dr. J. S. Owens gave a very interesting description of the removal by drilling and blasting of 11,000 tons of rock-reefs from the bed of a river. No divers were employed, but holes were drilled from a floating barge, using a 5-in. steam drill. "Sausages" of dynamite were fed into the holes through a pipe and fired electrically in groups of about eight holes. The cost was a mere fraction of what it would have been if divers had been employed.

University and Educational Intelligence.

BIRMINGHAM.—The first list of donations in response to the appeal of the University for 500,000*l.* has been published, showing gifts or promises to the amount of more than 250,000*l.* Nearly half of this amount, however, is given to the Petroleum Mining Endowment Fund, and, whilst making the University unique as a centre of instruction and research in this particular branch of engineering, it will not be directly available for relieving the general indebtedness. The largest single gift is an anonymous one of 50,000*l.* for the general fund. A sum of 5000*l.* is earmarked for a chair of Italian, and an equal amount is given by the James Watt Memorial Fund for a James Watt research chair in engineering. The Birmingham Small Arms Co. gives 6500*l.*, and the Daimler Co. 3500*l.* A gratifying feature of the list is the number of names of old students who have contributed. The Birmingham Chamber of Commerce has given 3200*l.*, and the Worcestershire Education Committee has made an additional grant of 200*l.* per annum. It is announced that a second list will be issued shortly, and it is to be hoped that more of the large firms in the city and neighbourhood will appear therein.

CAMBRIDGE.—Mr. A. F. R. Wollaston has been elected a fellow of King's College for his explorations in the Sudan, Ruwenzori, Pacific, and Dutch New Guinea.

DR. W. T. DAVID has been appointed professor of engineering at the University College of South Wales and Monmouthshire, Cardiff.

IT is announced that Prof. H. MacLean, professor of chemical pathology in the University of London, has been appointed director of the clinical medical unit at St. Thomas's Hospital. The appointment of a physiologist and biochemist to be director of a clinical medical unit is significant as indicating the modern tendency of medicine towards recognition of the value of the work of the scientific investigator for purely medical fields.

THE University of Manchester has recently received a bequest of 30,000*l.*, free of duty, under the will of the late Mr. Jesse Haworth. The amount is to be used for the purpose of enlarging the present Jesse Haworth Building for Egyptology. Mr. Haworth, to whose generosity the University owes the greater part of its valuable Egyptological collection, was always a most generous benefactor to the museum, and shortly before his death subscribed 10,000*l.* to the University Appeal Fund, this amount being earmarked for museum purposes. The University Appeal Fund now stands at about 217,000*l.*

THE Toronto correspondent of the *Times* reports that complete success is anticipated in the centennial endowment campaign to raise 1,000,000*l.* for McGill University, Montreal. Up to November 16 ten individual subscriptions of 20,000*l.* each, one of 10,000*l.*, and nine of 5000*l.* had been received. Among the chief contributors are Lord Atholstan, Mr. R. B. Angus, Col. Molson, Mr. J. W. McConnell, Sir Herbert Holt, and the Dominion Textile Co. On November 20 it was reported that the endowment fund exceeded 800,000*l.* Among the later heavy subscriptions are 50,000*l.* each by the Canadian Pacific Railway, the Bank of Montreal, and the Royal Bank, and 25,000*l.* by the Merchants' Bank.

THE annual general meeting of the Science Masters' Association will be held at Oxford from the evening of Tuesday, January 4, 1921, to the morning of the following Friday. Lodging accommodation for members of the association will be provided in the rooms of Balliol and Trinity Colleges. Meals will be served in Balliol College hall. Lectures, discussions, and demonstrations will take place in the lecture-rooms and laboratories of the University. The provisional programme includes the following addresses and lectures:—President's address: Some Aspects of Science and Education, A. Vassall; Indicators and the Law of Mass Action, Brig.-Gen. H. Hartley; The Study of Crystals, T. V. Barker; Glass Blowing, B. Lambert; Recent Advances in Genetics, J. S. Huxley; Spectroscopy, Prof. T. R. Merton; and The Hedjaz, Dr. D. G. Hogarth.

THE Hudson Bay Company, as one means of celebrating the 250th anniversary of its foundation and its long connection with Western Canada and with Winnipeg, recently offered the University of Manitoba a fellowship of the annual value of fifteen hundred dollars for the years 1920–29 inclusive. This fellowship, which the University has gratefully accepted, will be called the Hudson Bay Company Research Fellowship, and is open to graduates of any Canadian university. It is tenable at the University of Manitoba, and each fellow must devote his entire time to original research in some branch of pure or applied science (*i.e.* the natural and physical sciences, the medical sciences, engineering, and agriculture). Each fellow will be appointed for one year, and the first appointment will be made at an early date. The company and the University of Manitoba are to be congratulated upon the creation of this important research benefaction.

THE mayoral statement for 1920 of the Huddersfield Technical College has been issued. During the session there were 658 day and 2590 part-time students; the latter figure included some 300 apprentices who attended special afternoon classes. The total number of students enrolled showed an increase of 876 above the number for the previous year. Ex-Service students accounted in part for the large increase in numbers: those under the Board of Education scheme for the higher education of ex-Service students received training in industrial and general science; the remainder, under the Ministry of Labour industrial training scheme, had a more direct and practical training in numerous crafts and trades. The textile and the dye departments have been enlarged and a new research laboratory has been added to the chemical section, though the demand made by the increase in the numbers of students on the staff of the college has left little opportunity for the pursuit of such studies. External classes in non-vocational subjects have also been established. Two gifts have been received for the endowment of scholarships: one, to be known as the Joseph Blamires scholarship for chemical research, made by Mrs. Blamire, and another, a textile scholarship, made by Sir Charles Sykes.

Societies and Academies.

LONDON.

Zoological Society, November 2.—Sir Sidney F. Harmer, vice-president, in the chair.—Dr. A. **Willey**: A note on the respiratory movements of Necturus and Cryptobranchus.—J. H. **Lloyd**: Some observations on the structure and life-history of the common nematode of the dogfish, *Scyllium canicula*.—Mrs. O. A. Merritt **Hawkes**: Observations on the life-history, biology, and genetics of the lady-bird beetle, *Adalia bipunctata*, Mulsant.—Prof. H. R. **Mehra**: The sexual phase in certain Indian Naididæ (Oligochæta).

Linnean Society, November 4.—Dr. A. Smith Woodward, president, in the chair.—J. H. **Owen**: Further researches into the life and habits of the sparrow-hawk, *Accipiter nisus* (Linn.), Pall. After some preliminary remarks on some of the less known habits of the sparrow-hawk, the author showed a series of nearly eighty lantern-slides depicting various incidents of the incubation and nestling periods. The slides were from photographs of six different nests. Of special interest were series showing (1) the efforts of the hen to protect the nestlings from the effects of the sun, and (2) the behaviour of the hen during incubation as affected by climatic conditions.—H. N. **Dixon**: The mosses of the Wollaston Expedition to Dutch New Guinea. The mosses were, unfortunately, not described with the higher plants, but have since been worked out by the author, and have proved of great interest. Although consisting of only some sixty gatherings, the collection contained types of at least two new genera, Hymenodontopsis and Callistomium, and more than a dozen new species, including two new species of Dawsonia, a genus which is more highly represented in New Guinea than in any other part of its rather limited distribution. A further collection by the Rev. J. B. Clark, of the London Missionary Society, in the neighbourhood of Boku, British New Guinea, is also included, and contains ten new species, comprising a very beautiful Pterobryella, and other interesting things. A small species, probably of Rhizogonium, named provisionally *R. orbiculare*, may possibly represent the ancestral form of the Rhizogoniaceæ.

Mineralogical Society, November 9 (Anniversary Meeting).—Sir William P. Beale, Bart., president, in the chair.—Dr. E. S. **Simpson**: A graphic method for the comparison of minerals with four variable components forming two isomorphous pairs. In the spinel-chromite series the two pairs are MgO,FeO and Al_2O_3,Cr_2O_3, and the general formula is (Mg,Fe)O.$(Al,Cr)_2O_3$. The relative molecular preponderances of the components of each pair stated as a percentage of the maximum are given by the formulæ $x=100(m-f)/(m+f)$ and $y=100(a-c)/(a+c)$, where m, f, a, c represent the number of molecules of MgO, FeO, Al_2O_3, and Cr_2O_3 respectively. The values of x and y, calculated from a number of published analyses, and from new analyses of ceylonite from Camban, Western Australia, are plotted on rectangular co-ordinates. The four corners of the main square are occupied by the pure compounds MgO.Al_2O_3 (spinel), FeO.Al_2O_3 (hercynite), FeO.Cr_2O_3 (chromite), and MgO.Cr_2O_3 (here named picrochromite). Sub-species and varieties of intermediate composition are divided off in symmetrical areas within the square.—L. J. **Spencer**: Fibrolite (=sillimanite) as a gem-stone from Burma and Ceylon. Water-worn, prismatic crystals from the ruby mines in Upper Burma measure up to 1½ cm. in length, and are clear and transparent, with a pale sapphire-blue colour and marked pleochroism. A fine faceted gem cut from this material is shown in the British Museum collection of minerals. Determinations were given of the optical constants; the birefringence shows a wide range, $\gamma-\alpha$ being seventeen times $\beta-\alpha$. On a somewhat similar, but etched, crystal from Ceylon the axial ratios were determined. Other crystals from Ceylon are pale greyish-green with a marked chatoyancy.—Dr. J. W. **Evans**: The origin of the alkali rocks. The alkali-igneous rocks form an exceptional series varying in composition from acid to basic, characterised by a high percentage of alkalis, especially soda, and a deficiency in alumina and the oxides of the divalent elements. They appear to occur mainly in areas where the earth's crust has, as the result of ancient folding or the accumulation of granitic rocks, consolidated to a considerable depth, and where the temperature gradient is normally low. Such areas are rarely subject to new folding, but are frequently folded, and with these faults the alkali rocks appear to have a genetic relation. In such areas crystallisation must proceed in the sub-crustal magmas, which are believed to be basic in composition under exceptional pressure, with the result that minerals with low specific volumes, having regard to the materials of which they are composed, will preferentially crystallise out. Garnet, zoisite, fibrolite, and kyanite are examples the materials of which crystallise out under less pressure with greater specific volumes. As these minerals are mainly silicates of aluminium and the divalent elements, the uncrystallised residue will be poor in these constituents and rich in the alkalis, especially soda, which was present in the original magma in greater proportion than the potash. It will also contain the volatile fluxes in large amount. As a result of the faulting of the crust this residue may be pressed out, find its way upwards, and give rise by further differentiation to the alkali rocks.—A. F. **Hallimond**: Monticellite from a mixer slag. The crystals, which are essentially monticellite containing about 20 per cent. of olivine in solid solution, have the following physical characters: Orthorhombic, $a:b:c=0.4382:1:0.5779$; forms 010, 110, 021; refractive indices, 1·663, 1·674, 1·680; 2V, 73¼°; specific gravity, 3·20.—Dr. H. H. **Thomas** and A. F. **Hallimond**: A refractometer for the determination of liquid mixtures. A telescope and collimator with Websky signal are fixed in alignment; between them is inserted a parallel-sided trough containing the liquid to be determined, in which is immersed a right-angled prism of known index near that of the liquid. Two images of the signal are formed, and the angular distance between them is read on the eye-piece scale; this reading is proportional to the difference of index between the liquid and the prism. The scale division has the same value whatever the index of the prism used.

Royal Meteorological Society, November 17.—Mr. R. H. Hooker, president, in the chair.—C. E. P. **Brooks** and H. W. **Braby**: The clash of the trades in the Pacific. The mechanism of rainfall in the equatorial Pacific. Considering the months January to June, and first the area east of 180° long., the trades meet at a low angle. The south-east wind is the warmer, and therefore the less dense, and rises above the north-east wind on a long slant, beneath which eddies are formed, giving occasional west winds. From the rising south-east trade wind rain is condensed, and falls through the north-east or west winds. East of 180° long. the trade winds meet almost at right angles, and, as their densities are the same, they mingle and produce a great volume of rising air, forming a low-pressure area, into which air is drawn from all sides. This low-pressure area is a mobile "action centre," the position of which determines the character of the season: if it lies far to the west the season is dry; if it takes an easterly position the season is wet.—Dr. W. H. **Steavenson**: The mirage. The visibility of the mirage was found to be dependent solely on the distribution of temperature near the ground, so determined by the altitude of the sun. The appearance was, therefore, not necessarily associated with hot weather, and had been well seen when the shade temperature was below 50°. Investigations had shown that the old reflection theory was untenable, and that the phenomenon was purely a refraction effect. The appearance of the mirage was subject to variations which were dependent upon such factors as the contour of the ground, the height of the observer, and the altitude of the sun.

PARIS.

Academy of Sciences, November 2.—M. Henri Deslandres in the chair.—M. **de Sparre**: The ram-stroke in pipes feeding turbines with strong reaction. The ordinary formula giving the pressure in a water-main set up by a sudden stoppage of the motion of the water cannot be applied without serious error to mains supplying turbines with a strong reaction. The necessary modifications of the formula are given.—G. **Ciamician** and C. **Ravenna**: The biological signification of alkaloids in plants. Alkaloids have been regarded as refuse products which the plant is unable to eliminate. From an experimental study of the action of various alkaloids and substances related to them on young bean plants it is shown that this view cannot be sustained.—M. **Gevrey**: The resolution of problems at the limits relating to equations of the second order of elliptical and parabolic types.—B. **Gambier**: Couples of two minimum surfaces corresponding as focals of a rectilinear congruence, with conservation of the asymptotic lines and the lines of zero length.—M. **Risser**: An application of Volterra's equation to the problem of distribution by age.—MM. **Claude** and **Driencourt**: A new type of prism astrolabe. A description and photograph of the new instrument are given. Compared with the older type, it is less than half the weight and easier to set up and adjust.—M. **Holweck**: Experimental researches on X-rays of great wave-length. In the apparatus described ionising rays were produced for a difference of 70 volts between the anode and cathode; this would correspond to a wave-length of about one-sixth of Schumann's ultra-violet. Determinations were made of the coefficient of absorption of the soft X-rays in different gases.—J. **Cabannes**: Measurement of the luminous intensity diffused by argon. New determination of Avogadro's constant. The value found by this method is $6{\cdot}9\times10^{23}$, in good agreement with the well-known values of Millikan ($6{\cdot}07\times10^{23}$) and Jean Perrin ($6{\cdot}85\times10^{23}$).—MM. **Chauvenet**, **P. Job**, and **G. Urbain**: The thermochemical analysis of solutions. Equimolecular solutions of various salts are mixed in varying proportions, the volume being kept constant. The heat evolved on mixing is measured, taking account of the specific heats of the solutions. Curves are given illustrating the application of this method to the systems potassium iodide–cadmium iodide, copper chloride–aluminium chloride, and copper chloride–magnesium chloride. The formation of the complex salts, K_2CdI_4, $(2CuCl_2,3MgCl_2)$, $(3CuCl_2,2MgCl_2)$, $(CuCl_2,2AlCl_3)$, and $(2CuCl_2,AlCl_3)$, was clearly indicated by this method.—P. **Loisel**: The variations of the radio-activity of the springs of Bagnoles-de-l'Orne and their relation to the rainfall.—M. **Chopin**: An automatic indicator of the amount of moisture in cereals.—J. **de Lapparent**: Crystals of felspar and quartz in the limestones of the Middle Trias of Alsace and Lorraine.—G. **Depape**: The presence of *Juglans cinerea fossilis* in the Plaisancian flora of Saint-Marcel-d'Ardeche.—J. **Touch**: The diurnal variation of temperature in the Antarctic.—A. **Lumière**: The awakening of the soil. The activity in the soil, with rapid germination of seeds, which takes place in the spring, was at one time supposed to be caused by rise of temperature; this, however, was disproved by Müntz and Gaudechon, who showed that a maximum of microbial activity was produced independent of the temperature. Their suggestion that this recurrence of activity was to be ascribed to a predilection of the micro-organisms for a given period of the year, atavism, the author regards as unsatisfactory, and he now suggests another possible cause, the existence in the soil of toxic products secreted by the roots of plants or resulting from the transformation of vegetable débris after the fall of leaves and the death of annual plants. Experiments in support of this view are described. Soil collected in November was thoroughly washed to remove soluble toxic products, and at the temperature of the laboratory this soil produced vegetation with great rapidity. The same soil unwashed was sterile as regards growth. The washings, concentrated, were proved to prevent growth.—F. **Vincens**: Abnormal ligneous formations in the bark of *Hevea brasiliensis*.—J. **Dufrenoy**: The experimental bacterial tumours of Epicea.—J. **Delphy**: The reproduction of mudworms: fecundation, segmentation, and morphogenesis.—M. **Nicolle** and E. **Césari**: The effects and constitution of the antibodies.

NAPLES.

R. Accademia delle Scienze fisiche e matematiche, May 3.—Prof. Monticelli, president, in the chair.—F. **Tricomi**: Series of functions of lines.

May 8.—Prof. Montesano, vice-president, in the chair.—F. **Amodeo**: Researches of a Neapolitan eighteenth-century mathematician on certain theorems of Archimedes. Nicolò de Martino (born at Faicchio in 1701, died at Naples in 1769) rediscovered and proved by new and original methods several theorems in mensuration contained in the lost manuscripts of Archimedes. These, which were published in 1768 in a text-book on solid geometry and conic sections intended for Army cadets, show De Martino to have been a mathematician of great power.

June 7.—Prof. Monticelli, president, in the chair.—C. **Colamonico**: A zone of carso known as "vurgo" in the Bari territory. This forms part of a series of researches by the author on the carso of southern Italy. The present zone occurs in a little-known district of Apulia.—M. **Pascal**: N'ple integrals in the complex field.

June 12.—M. **Pascal**: Multiple integral of a differential form.

June 19.—F. **Tricomi**: Series of powers in the field of functions of lines, ii.

CAPE TOWN.

Royal Society of South Africa, September 29.—Dr. J. D. F. Gilchrist, president, in the chair.—J. R. **Sutton**: A possible lunar influence upon the velocity of the wind at Kimberley. IV. The object of this part of the discussion is to determine whether there are any points of agreement between the air tides and the lunar wind period sufficiently definite to form the nucleus of a theory which could be used to explain the comparatively great air speeds found in previous papers and attributable to the moon. For this purpose the air tides at perigee and at apogee have been determined (by Sabine's method) for the ten years 1897–1906 and compared with the wind movements. A diagram is given showing how the air pressures and wind movements compare one with the other. Both agree in the main, though with certain important exceptions confirming previous conclusions that the lunar influence upon the velocity of the wind cannot be exerted in a very simple way through the medium of the air tides.—J. P. **Dalton**: The integrated velocity equations of chemical reactions. The object of the note is to show how the integrals of many velocity equations which occur in practice may be written down in terms of a certain function of the relative initial concentrations of the reactants and of its derivatives.—C. **Pijper**: Medical folk-lore of the Abantu in the Lijdenburg district.

The paper contains contributions to our knowledge of the methods of treatment used by witch-doctors. —J. W. C. **Gunn**: The action of *Urginea Burkei*. Experiments were performed on frogs, rabbits, cats, rats, and guinea-pigs with extracts of *Urginea Burkei*, Baker, commonly known as the Transvaal slang-kop. It has an action on the alimentary system, producing vomiting and diarrhœa, and on the nervous system, resulting in loss of power in the limbs, diminution of reflexes, and final paralysis. Its main action is on the circulatory system.—G. A. **Boulenger** and J. H. **Power**: A revision of the South African Agamas allied to *Agama hispida*, *A. atra* and *A. anchietae*. The paper contains a revision of the group of South African reptiles which has stood most in need of revision. The account in the British Museum Catalogue of Lizards has long ceased to fulfil its purpose, and the attempt is now made, with the help of a very large amount of material, to arrive at conclusions which will stand the test of time.—S. H. **Skaife**: A species of Microdon (Diptera) from Natal. The paper gives a description of the larva, puparium, and adult female of *Microdon illucens*, Bezzi, the growth being under the author's observation.—J. D. F. **Gilchrist**: Note on living fish brought by H.M.S. *Challenger*.

SYDNEY.

Linnean Society of New South Wales, September 29.—Mr. J. J. Fletcher, president, in the chair.—Dr. J. M. **Petrie**: The chemical examination of *Macrozamia spiralis*. A complete summary of its poisonous record is given. In the leaves the following constituents were identified: Formic, acetic, valerianic, and lauric acids; oleic, stearic, and higher fatty acids; a volatile essential oil; a phytosterol; a paraffin with the properties of triacontane, and an olefine having the properties of octodecylene. The nuts contained 39 per cent. of starch and much mucilage. In feeding experiments white rats were given with their ordinary food (1) crushed fresh leaves, (2) grated seeds, (3) the rich, fatty, and resinous components extracted from the leaves by ether, and (4) aqueous extracts of the leaves and the seeds. The animals showed no signs of being affected after feeding for three weeks.—A. P. **Dodd**: Two new Hymenoptera of the superfamily Proctotrypidæ from Australia. A new genus is proposed in the family Diapriidæ, and a new species of Prosoxylabis (Belytidæ), the former being a primary parasite of the sheep-maggot flies.—Prof. W. N. **Benson**, W. S. **Dun**, and W. R. **Browne**: The geology and petrology of the Great Serpentine Belt of New South Wales. Part ix.: The geology, palæontology, and petrography of the Currabubula district, with notes on adjacent regions. The extrusive rocks comprise keratophyric tuffs of the Burindi and Kuttung series, with which are interbedded soda rhyolite flows and tuffs and basalt. The Werrie series consists of decomposed basalts, occasionally slaggy. Invading these, and also the underlying Kuttung and Burindi beds, is an immense series of sills and dykes comprising quartz keratophyre, quartz trachyte, quartz latite, andesite, lamprophyre, normal and albite dolerite, teschenite, and basalt. Attention is directed to the peculiar association of calcic and alkaline rock-types linked by intermediate types, and evidently derived from a common stock magma. Though the dominant rocks in this area are intrusive, and those in the Paterson, Seaham, and Pokolbin districts are effusive, the petrographical similarity of the Carboniferous igneous rocks in the two districts is most marked.—A. M. **Lea**: Descriptions of new species of Australian Coleoptera. Part xvi. Nineteen species and one variety of Ditropidus, three species of Elaphodes, and three species of Cœnobius are described as new. In addition, notes on synonymy, etc., partly the result of examination of some of Macleay's and Olliff's types from the Australian Museum, are given for seventy-one species belonging to twenty-two genera.

Books Received.

Physics: The Elements. By Dr. Norman R. Campbell. Pp. ix+565. (Cambridge: At the University Press.) 40*s*. net.

Newton. By Gino Loria. Pp. 69. (Roma: A. F. Formiggini.) 2.70 lire.

Text-book of Pastoral and Agricultural Botany. By Prof. John W. Harshberger. Pp. xiii+294. (Philadelphia: P. Blakiston's Son and Co.) 2 dollars.

The Gyroscopic Compass: A Non-Mathematical Treatment. By T. W. Chalmers. Pp. x+167. (London: Constable and Co., Ltd.) 11*s*. net.

Grains and Grammes: A Table of Equivalents for the Use of Numismatists. Pp. 35. (London: British Museum.) 3*s*. net.

Notes and Answers to Exercises in Practical Geometry and Theoretical Geometry. By C. Godfrey and A. W. Siddons. Pp. 26. (Cambridge: At the University Press.) 1*s*. 6*d*. net.

Lehrbuch der Paläozoologie. By Prof. O. Abel. Pp. xvi+500. (Jena: G. Fischer.) 40 marks.

Initiative in Evolution. By Dr. W. Kidd. Pp. x+262. (London: H. F. and G. Witherby.) 15*s*. net.

Territory in Bird Life. By E. Eliot Howard. Pp. xiii+308. (London: J. Murray.) 21*s*. net.

Coal in Great Britain: The Composition, Structure, and Resources of the Coalfields, Visible and Concealed, of Great Britain. By Dr. W. Gibson. Pp. viii+311+viii plates. (London: E. Arnold.) 21*s*. net.

A Text-book of Geology. By P. Lake and R. H. Rastall. Third edition. Pp. xiv+508+xxxiii plates. (London: E. Arnold.) 21*s*. net.

Scientific and Applied Pharmacognosy. By Prof. H. Kraemer. Second edition. Pp. xxviii+741. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 33*s*. net.

The Nature of Animal Light. By Prof. E. N. Harvey. Pp. x+182. (Philadelphia and London: J. B. Lippincott Co.) 10*s*. 6*d*. net.

Some Conclusions on Cancer. By Dr. C. Creighton. Pp. xiii+365. (London: Williams and Norgate.) 42*s*. net.

Kentucky Superstitions. By Dr. D. L. Thomas and L. B. Thomas. Pp. viii+334. (Princeton: University Press; London: Oxford University Press.) 12*s*. 6*d*. net.

The New Calendar of Great Men. Edited by Frederic Harrison. New edition. Pp. xx+708. (London: Macmillan and Co., Ltd.) 30*s*. net.

The Secrets of the Self (Asrár-I Khudī). A Philosophical Poem. By Sheikh Muhammad Iqbal. Translated from the original Persian by Dr. R. A. Nicholson. Pp. xxxi+147. (London: Macmillan and Co., Ltd.) 7*s*. 6*d*. net.

A Text-book of Plant Biology. By Prof. W. N. Jones and Dr. M. C. Rayner. Pp. viii+262+vi plates. (London: Methuen and Co., Ltd.) 7*s*.

British Mammals. Written and illustrated by A. Thorburn. In 2 vols. Vol. i. Pp. vii+84+25 plates. (London: Longmans, Green and Co., Ltd.) 2 vols. 10*l*. 10*s*. net.

Organic Chemistry for Advanced Students. By Prof. J. B. Cohen. Third edition. Part i.: Reactions. Pp. viii+366. Part ii.: Structure. Pp. vii+

435. Part iii.: Synthesis. Pp. vii+378. (London: E. Arnold.) 18s. net each vol.

Australasian Antarctic Expedition, 1911–14. Scientific Reports. Series C: Zoology and Botany. Vol. v., part 7: Ostracoda. By F. Chapman. Pp. 48+2 plates. 4s. 7d. Vol. v., part 8: The Insects of Macquarie Island. By Dr. R. J. Tillyard. Pp. 35. 2s. 9d. Vol. vii., part 1: Mosses. By H. N. Dixon and the Rev. W. W. Watts. Pp. 9. 1s. Vol. vii., part 2: The Algæ of Commonwealth Bay. By A. H. S. Lucas. Pp. 18+9 plates. 3s. 6d. Vol. vii., part 3: The Vascular Flora of Macquarie Island. Pp. 63. 6s. 6d. Vol. vii., part 4: Bacteriological and other Researches. By Dr. A. L. McLean. Pp. 130+11 plates. 16s. (Sydney: W. Gullick.)

Diary of Societies.

THURSDAY, NOVEMBER 25.

ROYAL SOCIETY, at 4.—Special General Meeting to consider the Annual Report of Council.—At 4.30.—Prof. L. Hill: The Growth of Seedlings in Wind.—Prof. P. T. Herring: The Effect of Thyroid-feeding and of Thyro-parathyroidectomy upon the Pituitrin Content of the Posterior Lobe of the Pituitary, the Cerebro-spinal Fluid, and Blood.—W. A. Jolly: Reflex Times in the South African Clawed Frog.—Prof. J. A. Gunn and R. St. A. Heathcote: Cellular Immunity. Observations on Natural and Acquired Immunity to Cobra Venom.—L. T. Hogben: Studies on Synapsis. III. The Nuclear Organisation of the Germ Cells in *Libellula depressa*.

CHADWICK PUBLIC LECTURES (at the Medical Society of London), at 5.15.—Prof. J. B. Farmer: Some Biological Aspects of Disease.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—W. B. Woodhouse: The Distribution of Electricity.—R. O. Kapp: Some Economic Aspects of E.H.T. Distribution by Underground Cables.

CONCRETE INSTITUTE, at 7.30.—E. F. Etchells: Presidential Address.

EGYPT EXPLORATION SOCIETY (at Royal Society), at 8.30.—Prof. G. Elliot Smith: The Royal Mummies.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.

FRIDAY, NOVEMBER 26.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 5.—Dr. D. Drury: Malformation of the Face, Ear, Eye, and Hand occurring in an Infant.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Section) (at the City and Guilds Technical College, Leonard Street, E.C.), at 6.30.—A. J. C. Watts: Electricity and the Paper-making Industry.

OPTICAL SOCIETY AND PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 7.—The Making of Reflecting Surfaces. (*a*) Technical Methods of Production.—R. Kanthack: Description of the General Features of Published Processes.—H. N. Irving: Methods of Silvering.—J. W. French: Workshop Notes on Silvering.—F. Ellerman and H. D. Babcock: The Silvering of Glass Reflectors.—J. Rheinberg: Platinum Reflecting Surfaces on Glass by the Burning-in Process.—R. S. Whipple: The Silvering of Glass and Quartz Fibres.—H. A. Hughes: Demonstration of a Silvering Process.—C. W. Davidson: The Silvering of a Large Reflector. (*b*) Reflecting Powers of Surfaces, etc.—J. W. T. Walsh: The Photometric Measurement of the Reflecting Powers of Mirrors.—Prof. Féry: A Note on some Permanent Mirrors for Reflecting Heat Radiations.—W. G. Collins: Rustless Steel Mirrors.—R. W. Cheshire or Dennis Taylor: Note on Increasing the Transmitting Powers of Surfaces.—F. Simeon: Demonstration of Apparatus used for Producing Mirrors by Cathodic Bombardment.

JUNIOR INSTITUTION OF ENGINEERS (at Caxton Hall), at 8.—C. O. Mourant: Reinforced Concrete Coal Bunkers and Silos.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.), at 8.—Resumed Discussion on Paper by Prof. W. Yorke: The Present Position of Trypanosomiasis Research.—G. Dudgeon: Some Important Tropical Fruit Foods.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.30.—Dr. A. Chaplin: Measures for Preserving the Health of Seamen on Board Ship.

MONDAY, NOVEMBER 29.

THE INSTITUTE OF ACTUARIES (in Staple Inn Hall), at 5.—Sir Alfred Watson: Address.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting) (at Chartered Institute of Patent Agents), at 7.—A. F. Harmer and Others: Discussion on Electrical Transmission on Petrol Vehicles.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Professional Questions.

ROYAL SOCIETY OF ARTS, at 8.—A. Chaston Chapman: Micro-organisms and some of their Industrial Uses (Cantor Lecture).

TUESDAY, NOVEMBER 30.

ROYAL HORTICULTURAL SOCIETY, at 3.

ROYAL SOCIETY, at 4.—Anniversary Meeting.

ROYAL SOCIETY OF MEDICINE (Tropical Medicine Section), at 5.—Dr. F. G. Rose: The Incidence of Filariasis in British Guiana.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Technical Meeting), at 7.—G. C. Weston: Dark Room Dodges.

WEDNESDAY, DECEMBER 1.

GEOLOGICAL SOCIETY OF LONDON, at 5.15.—Special General Meeting.—At 5.30.—Ordinary Meeting.—Dr. E. Greenly: An Æolian Pleistocene Deposit at Clevedon, Somerset.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—R. V. Wadsworth: Estimation of Theobromine.—B. S. Evans: A New Process for the Estimation of Small Quantities of Chromium in Steels.—P. V. and F. H. Dupré: Some Notes on the Reactions between Fulminate of Mercury and Sodium Hyposulphite.

ROYAL SOCIETY OF ARTS, at 8.—Miss L. F. Pesel: Embroidery: National Taste in relation to Trade.

THURSDAY, DECEMBER 2.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.—Major G. H. Scott: Airship Piloting.—Flight-Lieutenant F. L. C. Butcher: Airship Mooring.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. W. Brown: The Value of Suggestion in Education.

CHEMICAL SOCIETY, at 8.—Sir Prafulla C. Rây: Varying Valency of Platinum with Respect to Mercaptanic Radicles.—H. E. Cox: The Influence of the Solvent on the Velocity of certain Reactions. Part II. Temperature Coefficients. A Test of the Radiation Hypothesis.—K. J. P. Orton and P. V. McKie: Preparation of Chloropicrin from Picric Acid and Trinitrotoluenes.

FRIDAY, DECEMBER 3.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Committee), at 5.—Discussion: The Cause of Magnetic Storms.—In Chair: J. H. Jeans. Opener: Prof. F. A. Lindemann.—Other Speakers: Prof. S. Chapman, Dr. C. Chree, Rev. A. L. Cortie, E. W. Maunder, C. S. Wright, and Others.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Further Discussion on The Human Factor in Industry, by A. Ramsay.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Section) (at King's College), at 6.30.—A. Serner and Others: Discussion on The Modern Tendency to Trusts. Is it Beneficial?

SATURDAY, DECEMBER 4.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—H. J. Elwes: The Primitive Races of Sheep in Great Britain.

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THURSDAY, DECEMBER 2, 1920.

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The Application of Science to Agriculture.

THE circumstances of the time call for the fullest possible utilisation of the national resources of both men and material, and never has there been more urgent need for the high training and intellectual interests that science can give to mankind, or for the properly directed application of science to national problems. When rapid changes are coming about before our eyes, and the community is being shaken to its foundations, it is essential to inquire whether the guardians of scientific studies in this country are still able to maintain the work at a proper level of efficiency. What, for example, is the position of the application of science to agriculture—the greatest of our industries? There have been some recent developments, though on a relatively small scale. If, however, a satisfactory organisation is possible in this case, there will be much ground for hope that the more general problem of the application of science to industry as a whole can be solved.

Prior to the war the application of science to agriculture was brought about in the main by the enterprise of a few individuals such as Lawes and Gilbert, of Rothamsted; Spencer Pickering, at the Woburn Fruit Farm; the Voelckers, father and son; and a few others. The landowner, as a rule, looked on in a not unfriendly way, but, his education never having been good, he was unable to understand what the man of science was trying to do. Character was his strong point; he administered justice in the village, while his wife dispensed charity; both were, as a rule, conscientious, hard workers, strong in the faith that they were doing the right thing, and true to the ideals that had been handed down to them by a long line of ancestors like themselves. It was not until 1894 that any sort of beginning was made in the country, when the so-called "whisky money" was available for technical education, and the county authorities had the option of developing agricultural education.

A few did so: Kent and Surrey combined to open the Wye Agricultural College; Norfolk and the eastern counties supported a school at Cambridge. The county bodies, however, did little for science. A distinction was made between "education" and "research"; if a teacher were repeating something already known, he was eligible for a Government grant, and was, therefore, a person who could be encouraged; but if he were seeking to discover something unknown, he was not eligible for grants, and was rather a problem for the authorities. Fortunately, however, institutions in the country cannot be completely governed from Whitehall, and common sense has a way of prevailing; much scientific work was, in point of fact, carried out by keen men working on their own account, and often in part at their own expense.

It was not until the passing of the Development Act in 1911 that Government support was forthcoming for scientific investigations in agriculture. The Act set up a Development Fund which subsidised certain institutions and allowed of much needed expansion. Considerable experience has been gained during the past ten years of the best method of utilising the available resources. The broad result is a threefold scheme, including: (1) Research institutions where agricultural science is developed; (2) colleges and farm institutes where instruction of various types is given to students wishing to become experts, farmers, etc.; (3) county advisers attached to some of the foregoing institutions, whose function it is to advise farmers on the various problems or difficulties with which they may be confronted.

At the beginning a rather large number of research institutes was set up, mainly at the universities. Of recent years there has been a tendency towards centralisation, four of the new institutes being afterwards transferred to other institutes already in existence. This was not originally intended, and, so far as is known, formed no part of a deliberate policy; it was the inevitable result of workers in different lines finding so much common ground that close association became essential. An institute such as Rothamsted, with excellent laboratories and library, standing in its own grounds of 300 acres, right out in the country, with well-kept historic field plots and a staff of assistants highly trained in field work, has obvious advantages over a university department situate in a town remote from agricultural practice and interests, and one is not surprised to find that it has grown and is still growing. The larger institutes now are: Rothamsted, for soil, plant nutrition, plant pathology (including entomology, helminthology, and mycology); the Imperial College, South Kensington, for plant physiology; Cambridge, for plant breeding and animal nutrition; Long Ashton and East Malling, for fruit; Reading, for dairy; Aberdeen, for animal nutrition; and Oxford, for agricultural economics.

Success or failure, however, depends on the men working the scheme, and shortly after the Armistice the Ministry of Agriculture put into operation a research service scheme, which has been found satisfactory in its essential features, and has enabled the leading research institutions to attract a body of highly competent workers and to retain those who wish to stay. Automatic increments of salary are made annually, subject to proved service, up to a certain maximum, and there is the possibility of promotion to a higher grade. As the scheme stands at present, a young man or woman taken on the staff begins with a salary which, including bonus, amounts to 450*l.* per annum, and he or she can rise continuously to a salary which, with bonus, amounts to 1010*l.* per annum. It does not follow that all will rise to this level; there are stopping places at 510*l.* and 780*l.* respectively, beyond which further progress may be impossible for a given individual. In addition, there is a superannuation scheme, to which the institute makes an annual contribution equal to 10 per cent. of the salary There are also still higher posts as directors, etc.

In the commencing or third grade the substantive salary is 300*l.* per annum, with bonus of 150*l.*, total 450*l.*, rising by annual increments of 20*l.* to 360*l.* *plus* 150*l.*—*i.e.* 510*l.* per annum. Should it appear that the holder is unsuited for the higher posts, the institute may terminate the appointment after three years. On the other hand, if paucity of posts or other reasons render promotion improbable, the institute may make the appointment permanent, provided sufficiently good work has been done to justify this course. Probably, in most institutes—certainly in the larger ones—there are excellent workers in the third grade for whom promotion into the second grade is only a remote contingency.

The middle- or second-grade appointments are limited in number—usually to half of those in the commencing grade—and the possibility of promotion thereto depends on the accident whether or not a post happens to fall vacant. Such cases inevitably arise under any scheme. The salary with bonus begins at 550*l.*, and rises by increments of 23*l.* to 780*l.* The highest or first-grade posts are also limited in number, being generally the same as the second grade; the commencing salary with bonus is 780*l.*, rising by eight annual increments to 1010*l.* The terms of appointment to these two grades are the same as those of a permanent reader at a university, so there is ample security of tenure. Above these come the directors, posts which, however, vary according to the institute.

Although the scheme is put forward, financed, and imposed on the research institutes by the Ministry of Agriculture, the holders of the posts are neither Civil Servants nor officers of the Ministry. The appointments to all these posts are made by the governing bodies of the institutes, which retain all rights of such bodies. In case of a grievance, any holder of a post has, however, the right of appeal through the governing body to the Ministry.

Promotion to a vacancy in a higher grade is possible only on the recommendation of the governing body and with the approval of the Ministry. There is a provision that all vacancies in higher grades must be notified to all likely candidates in the lower grades at all research institutes, but the appointment rests with the governing bodies, which, in the interest of their institutes, will presumably select the best candidate, whether in the service or out of it. As the scheme was originally put forward, there was a seniority clause giving preference to men or women already in the service; but this met with so much opposition from those responsible for the efficient conduct of the institutes that it was abandoned. A research institute is no place for promotion by seniority. Such promotions would stultify the whole purpose of research; they would stifle initiative, blot out all possibility of bringing in new ideas, lead to stereotyped dogmas, and do infinite harm to the cause of progress. At all costs, a research institute must choose the best possible man or woman, regardless of other considerations. Only in this way is it possible to bring in the new ideas and the new light which alone make research successful.

The reception of the scheme by the younger scientific workers has been very satisfactory, and the responsible authorities of the institutes have been in the gratifying position of finding excellent candidates for their posts. At no time in the last twenty years have the research institutes been better staffed than now.

Provision has also been made for the creation of a link between the university and the research service. The Ministry of Agriculture awards scholarships of the value of 200*l.* per annum to men and women, possessing an honours degree or equivalent qualification, who are desirous of entering the service. The successful candidates are attached to whichever institutes they may prefer, and have their opportunity in the event of a vacancy occurring. They will, however, usually find other scholarship holders at the institutes—1851 Exhibitioners, various university scholars, and other post-graduate workers also waiting for posts—and they can hope for appointments only if they happen to be the best of the available candidates.

Thus the scheme provides for selection from the universities of the most promising young men and women for research work; it allows of a probationary period in which each candidate can show his or her fitness for the work; it affords permanent posts for those finally chosen; it gives increments of salary commensurate with the value imparted by experience; and for the highly gifted worker it affords prospects of promotion to posts which, considering their freedom from routine duties and from worries, must be regarded as distinctly good. The scheme is economical and effective; it works with the minimum of friction and without interference with the individual research worker; and it may confidently be recommended as a model to other Government Departments which are concerned with the promotion of scientific research.

Philosophy of Relativity.

The General Principle of Relativity: In its Philosophical and Historical Aspect. By Prof. H. Wildon Carr. Pp. x+165. (London: Macmillan and Co., Ltd., 1920.) Price 7s. 6d. net.

PROF. WILDON CARR has produced in this little volume a really valuable book. There was an hiatus in the current expositions of the principle of relativity. Its significance and importance had been clearly set forth in their bearing on mathematical physics. But the doctrine had not been connected with its position in the history of general philosophical thought. This Prof. Carr has now done, and with great knowledge of philosophy.

After explaining the old difficulties, he shows how Descartes and Leibniz had partially recognised their origin. The exposition of the discussions by each of these thinkers is lucid and informing. In particular, there is an admirable explanation of the Leibnizian theory of monads, and of how Leibniz was driven to its adoption. Both philosophers were mathematicians of great eminence. They saw that the explanation of matter must come after that of movement, and could not precede it. Extension was not "stuff." The explanation of gravitation given by Newton follows. The book goes on to deal with the difficulties that led to Einstein's revision of the whole of the Newtonian hypothesis of space and time as absolutely existing frameworks. The special principle of relativity is then explained, and it is shown that the general, or later, Einstein principle is simply a full statement of what is implied in its earlier form. The first dealt with a definite phenomenon—the velocity of light. The second extends the explanation to the laws of Nature generally. There is no longer a particular finite velocity taken to be a constant and limiting one. As soon as we extend the special case of relativity to non-uniform and rotational systems of motion, the doctrine of equivalence between the experience of the observer taken to be at rest, and the experience of the observer in another system relatively to which the observer taken to be at rest is regarded as being in motion, becomes apparent. The explanation of the possibly non-Euclidean character of space systems, and of the necessity of correlating observations by adequate formulæ of transformation, becomes clear. The idea of pure objectivity disappears. Mind appears as relating the centre of a universe which is no longer infinite in the sense given to the word as applied to Newtonian space. For the observer is not a fixed point existing at a fixed instant. "Space and time are not containers, nor are they contents; they are variants. They change as my system of reference changes."

One of the difficulties experienced in reading even Einstein himself is the lack of a thoroughgoing connection of his principle with the new character really given by it to space and time. They are discussed as though they remained changed, not in kind, but in degree only, and based on what is original and still present, transformed in shape and measurement only. But more than this is implied in Minskowski's famous discourse at Cologne in 1908, which Einstein seems to adopt. The former deposed the intuitional space and time of our supposed direct experience to the status of mere shadows. The reality was to be sought in "the world-line," in a *continuum* the factors in which were not space and time, but deeper lying and inseparable phases of reality, to which space and time present only imperfect analogies. Some of the language of modern mathematical writers is obscured by the employment of words suggesting that we have only to correct imperfections in the description of our space and time as actual facts. Minskowski, on the other hand, seems to point to the reality being something radically different from the space and time of our discourse in science even of the most modern type. "Die dreidimensionale Geometrie wird ein Kapitel der vierdimensionalen Physik. Sie erkennen, weshalb ich am Eingange saghte, Raum und Zeit sollen zu Schatten herabsinken und nur eine Welt an sich bestehen." There is one English mathematical writer who has seized on the full meaning of this interpretation and carried it out to its logical conclusions in his "Concept of Nature." I refer to Prof. Whitehead.

The metaphysical foundations of this further view of Einstein's doctrine are made apparent in Prof. Carr's book. That is what makes it important for scientific readers, as well as for the general public, who will gather from it what the principle of relativity means. Like all books on this subject, it requires careful reading and unbroken attention, but the time these necessitate, even for this short book, will, I think, be found to have been thoroughly well spent.

HALDANE.

The Human Hand.

The Principles of Anatomy as Seen in the Hand. By Prof. Frederic Wood Jones. Pp. viii + 325 + 2 plates. (London: J. and A. Churchill, 1920.) Price 15*s*.

IN this work Prof. Wood Jones has made a notable contribution not only to the literature of human anatomy, but also to that of philosophical biology. The book is the result of an intensive study of a single part of our anatomy undertaken in the belief that if we understand it thoroughly and correctly we shall understand much more—shall, in fact, know the principles upon which the whole of our anatomy is formed. In selecting the hand for his purpose the author has chosen wisely, for it is, we think, without doubt the part which is most characteristic of us—that which has played the chief *rôle* in our development. Prof. Wood Jones's method is to take the various tissues forming the hand—viz. the skin, nails, fasciæ, bones, muscles, vessels, and nerves—separately, describing them in considerable detail from both the morphological and the practical points of view. As we can readily imagine, he is not able to confine himself strictly to the hand, any more than was Sir Charles Bell in his century-old book on the same subject. (We might say in passing that the comparison between the two books, which are further alike in that they are largely illustrated by the authors themselves, is extremely interesting and illuminating, as showing the great advance in our knowledge and the great change which has come over our conception of man's place in Nature during the last hundred years.)

From internal evidence alone the book appears to have been begun as a morphological study, and to have been given its practical bias in consequence of experience with patients suffering from nerve lesions acquired in the war. The fact—if fact it be that this was the order of its evolution—will go far, we think, to explain the peculiar value and interest of the book. It is seldom that anatomy is treated from both the morphological and the practical points of view; here, however, we have a book in which this is not merely observed, but impartially observed, with a result which, we believe, completely justifies those who look upon morphology as the guiding spirit of anatomical research, and upon anatomy itself as the only solid basis on which scientific medicine and surgery can be founded. An admirable example of the close connection which exists between morphology, anatomy, medicine, and surgery is, we think, to be found in the chapter on the skin creases or flexure lines, subjects which, we agree with the author, have not been given the consideration they deserve by either the physician or the surgeon.

In the chapter on the osteology of the hand the form of the primitive vertebrate hand is discussed at some length, and the conclusion reached that the primitive hand was not only pentadactylous, but also characterised by a smaller number of phalanges in the preaxial digit. The discrepancy in the number of phalanges in this digit compared with those in the other digits may, of course, be due to a decrease in the preaxial or to an increase in the other digits. Despite the fact that, as is pointed out and emphasised, no animal living or extinct has more than two phalanges in the preaxial digit, whereas the number of phalanges in the other digits is frequently subject to increase, Prof. Wood Jones accepts the former of the two alternative explanations, and hazards the opinion that the reduction has been brought about by the fusion of the two terminal phalanges. If on this matter he is not so logical as we could wish, we are more content with him in certain of his other explanations, and think the reasons he gives for the fusion of the fourth and fifth carpalia and tarsalia to form the unciform and cuboid, and for the shifting of the axis of the foot from the line of the third toe to that of the second, both adequate and ingenious. We are inclined also to accept his view of the fate of the os centrale, although here, as in other parts of the book, we think it would have been well if the evidence from morphology had been supplemented with that obtainable from embryology. The curious order in which the bones of the hand ossify is a matter upon which we should like to have had some light, but, unfortunately, none is forthcoming.

In the chapter on the extrinsic muscles of the hand reference is made to the muscles of the foot, and the extensor brevis digitorum and the peroneus tertius are spoken of as derivable from a deep extensor sheet, the slips to the four inner toes passing down into the foot, while the slip to the little toe remained in the leg as the peroneus tertius. This is a view of the origin of these muscles which is in direct opposition to those of Ruge, Bryce, and Keith, for they have shown that the extensor brevis digitorum, despite its innervation, has entered the foot, not from above, but from behind, passing under the external malleolus, while the peroneus tertius has originated in quite a different fashion—by segmentation of the extensor longus digitorum. The matter is, of course, of almost purely morphological interest, but we have ventured to refer to it because of the interesting problem presented by the nerve-fibres for the extensor brevis digitorum changing from the musculo-cutaneous branch to the anterior tibial branch of the external popliteal nerve.

Perhaps the most original and valuable part of the book is that dealing with muscles and their action. Here we have the results of a singularly close study of the various muscles of the hand, both in health and in disease, both after organic lesions and after functional disturbances, results which enable the author to furnish us with the very useful classification of muscles into prime movers, antagonistic, synergic, and fixation muscles, according to the particular part they play in different movements. We are also given the exact meaning of the phrase "at rest" as applied to a limb or a muscle, and supplied with a physiological explanation as to when and why the position of rest is attained. The distinction between a limb which is immobilised or mechanically at rest and one naturally at rest is clearly drawn. In the chapters dealing with the nerves an interesting summary is given of the most recent work of Head, Elliot Smith, Kinnier Wilson, and other neurologists—a summary supplemented by many original observations and speculations, as, for example, the particular association of trophic effects with injury to the median nerve, and the possibility that the Pacinian corpuscles are part of the sympathetic sensory system the fibres of which in the hand run mainly in the median nerve.

Altogether, the book is one which, in our opinion, places its author in the front rank of anatomists, and does more, we think, than any book published in recent years to rehabilitate the subject of anatomy, and restore it to its rightful place as the most fundamental and pervasive subject in the medical curriculum. W. W.

Identification of Monosaccharides.

Anleitung zum Nachweis, zur Trennung und Bestimmung der reinen und aus Glukosiden usw. erhaltenen Monosaccharide und Aldehydsäuren. By Dr. A. W. van der Haar. Pp. xvi + 345. (Berlin: Gebrüder Borntraeger, 1920.) Price 64 marks.

THROUGHOUT the development of organic chemistry the glucosides have maintained, amongst phytochemical products, a position of interest primarily due to their connection with sugars. Their attraction as materials for chemical study is intrinsic also, because they present alluring structural problems, and reveal the power of sugar molecules to combine with a great variety of other types—for example, in amygdalin, myronic acid, indican, and salicin. Furthermore, it is largely upon the production and examination of artificial glucosides that our present conception of glucose itself is based.

The diagnosis of a natural glucoside is complete only when the carbohydrate component has been identified, and chemists have long been conscious of the difficulties inherent to such an operation, especially when only small quantities of material are available. The purpose of the work under review is to facilitate this procedure, and the author has assembled in concise form the vast collection of experimental observations which have been accumulated in this field. Thus the volume offers ample and valuable information to those concerned in the identification of monosaccharides.

It is axiomatic that in such a treatise much attention should be devoted to the formation and properties of the large class comprising condensation products derived from substituted hydrazines, and the latter half is allotted almost entirely to this voluminous branch. The service thus rendered is conspicuous, for, in addition to arranging in logical sequence the numerous and scattered records of previous investigators, the author has elaborated methods based on his own research for dealing with mixtures containing two, three, and four monosaccharides. Due notice is given also to the recognition and estimation of glycuronic acid, the importance of which in glucoside chemistry is well known. The two concluding chapters provide detailed examples of the application to typical cases of the analytical processes under discussion.

The appearance of such a book emphasises in a very remarkable manner the facilities for monograph production offered by German publishers, and concurrently illustrates the difference in treatment adopted by Continental and by Anglo-Saxon authors. Van der Haar's treatise must be accepted as faithful and complete when viewed as a record of facts, yet it is useful only to a small number of specialists, whilst E. F. Armstrong's "Simple Carbohydrates and the Glucosides," dealing with identical materials, appeals alike to students, specialists, and general practitioners of organic chemistry. One presents the bones for sixty-four marks, the other makes a personal introduction to a living body for twelve shillings.

The present work is admirably produced, and remarkably free from errors, most of which are conveniently overtaken in a list of corrections on the concluding page; but the absence of a subject-index is to be regretted. M. O. F.

Our Bookshelf.

Solubilities of Inorganic and Organic Substances. By Dr. Atherton Seidell. Second edition, enlarged and thoroughly revised. Pp. xxii+845. (London: Crosby Lockwood and Son; New York: D. Van Nostrand Co., 1920.) Price 45*s*. net.

SOLUBILITY determinations are often incidental to other investigations, and are, consequently, not indicated in the title of the original paper, or included in the index of the journal in which they appear. For this reason such data are often difficult to locate, and Dr. Seidell's well-known compilation is a valuable contribution to chemical literature.

Originally published in 1907, the work was the first successful attempt to present a critical survey of available quantitative solubility data and to select from the discordant results of different observers the most trustworthy values for any given substance. An enormous mass of solubility data has since accumulated, and the present much enlarged edition, which brings the subject-matter up to 1918, is certain of a warm welcome. The nomenclature, especially of organic substances, has been revised, and the scope of the work extended to include freezing- or melting-point data for binary and ternary systems.

The author has endeavoured to maintain "unremitting vigilance" to avoid errors, but attention may be directed to an unfortunate lapse in the second table on p. 518, where an error has been made in converting milligram-molecules into grams, and where KOH ought to be K_2O. All the values in the fourth and fifth columns are wrong. In some cases the author has detected errors in calculation of original results, and indicates the necessary corrections—*e.g.* under strontium formate (p. 681) and ammonium perchlorate (p. 43).

New features in the present edition include a detailed explanation of the tables for the guidance of those more or less unfamiliar with the usual tabular methods of expressing such data; a chapter describing some of the methods used for the accurate determination of solubilities, with excellent diagrams; and an author index, with references to all the original papers consulted.

S. A. K.

Small Holding and Irrigation: The New Form of Settlement in Palestine. By Dr. S. E. Soskin. Pp. 63. (London: George Allen and Unwin, Ltd., 1920.) Price 2*s*. net.

THIS small publication has been issued by the Zionist Organisation in the interests of agricultural and horticultural settlements in Palestine. Intensive gardening is the main theme, and the application of the water resources of the country to the development of vegeculture, as a primary industry, is strongly urged. "The intensive utilisation of the irrigable areas for vegetable and fruit plantations should not come at the end of a period of development of years and decades, but at the beginning of our work of reconstruction in Palestine." After the preface and introduction, the subject is elaborated in four chapters. The first chapter deals with the general principles of irrigation in Palestine, as also does the introduction, contrasting the climatic conditions with those which obtain elsewhere in tropical and subtropical regions. It is claimed that artificial irrigation will work wonders, rendering two, three, and even four crops a season a possibility. The second chapter discusses the features of intensive gardening and the utilisation of manures and other adjuncts to cultivation. Tomato growing is represented as a promising venture, as also is the cultivation of the banana. The next chapter, headed "A Garden City," indicates the opportunities for, and the value of, co-operative effort. The last chapter is a brief, final word on the essential preparations for the first settlements under the scheme.

Every Boy's Book of Geology: An Introductory Guide to the Study of the Rocks, Minerals, and Fossils of the British Isles. By Dr. Arthur E. Trueman and W. Percival Westell. Pp. 315. (London: R.T.S., n.d.) Price 6*s.* net.

THIS is a good introduction to geology, lucidly written and thoroughly up-to-date. The illustrations are simple, and are line-sketches only, but they convey their meaning. The authors rightly presume that those who read their chapters are prepared to be interested in the subject. There is no talking round about, in the hope of disguising what is going to be a lesson rather than a mere encouragement to learn. There is not much room for originality in the selection of the facts put forward; but the merit of this book lies in its accuracy and simplicity of statement. The old discussions that were at one time held to be necessary in every text-book, such as the evidence of earth-movement afforded by coral-reefs, are wisely left to larger treatises. The suggestions we have to make are merely trivial. It seems cumbrous nowadays to write the names of chemical elements and compounds with capital letters. On pp. 32 and 131 felspars and beryl are respectively described as of "very complex" composition; but, when the reader has learnt the use of chemical symbols, he will not find matters so alarming. On p. 33 "twinning" should be omitted or more exactly defined. Potash is as important in biotite as in muscovite (p. 35). It is not at all necessary for a limestone to be melted before passing into crystalline marble (p. 73). We are glad to note the recommendation of a bicycle to the young explorer in our islands. Fossils do not necessarily lie on the tracks of chars-à-bancs.

G. A. J. C.

Education for Self-realisation and Social Service. By Frank Watts. (The New Humanist Series.) Pp. xii+275. (London: University of London Press, Ltd., 1920.) Price 7*s.* 6*d.* net.

UNDER the title of "The New Humanist Series," with Mr. Benchara Branford as editor, the University of London Press is projecting a series of volumes in which "the most modern advances of knowledge will be sought in order to fructify the many and varied fields of education. The subjects of the curriculum will be discussed by experts not too far removed by time from their own school years." These will be preceded by general volumes, of which the present book is the first. The treatment is adequate, and may be profitably compared with that of Prof. Nunn in the opening volume of another educational series. Without neglecting the rather intellectualistic psychology on which teachers of an earlier generation were brought up, it seeks the foundations of character and conduct in the innate tendencies to which the child is heir from an evolutionary past. The work of psycho-analysts is laid under contribution, and some of their terms, such as "sublimation," are adopted or adapted. In a diagrammatic "Tree of Human Development," from roots in *l'élan vital*, two main stems, the nutritive *hormic* and the distributive *libido*, arise, and from the latter are derived the flower and fruitage of the sublimated will or *eros*. There are many practical suggestions which will be found of value by teachers.

Utilisation des Algues Marines. By Prof. Camille Sauvageau. (Encyclopédie Scientifique: Bibliothèque de Botanique Appliquée.) Pp. vi+394. (Paris: Octave Doin, 1920.) Price 7.50 francs.

MANY possible uses of seaweeds are described in Prof. Sauvageau's excellent treatise—agricultural, industrial, alimentary, therapeutic. Their value as manure is great, but is limited by cost of carriage. Among industrial uses of brown algæ may be mentioned the kelp industries, formerly so profitable as the source of soda, and still yielding potash, iodine, and bromine. Algin, norgin, and tangin are patented products used as dressings for textiles, etc., as also are the mucilages extracted from red algæ. During the war acetone was produced on a large scale by fermentation of brown algæ in American munition factories, and used as a solvent for gun-cotton, etc. By a similar fermentation, alcohol can be manufactured in quantity for motor fuel. The Germans devised a "fuse" of Laminaria to explode shells falling into water. Algæ, though commonly eaten in Japan, China, and elsewhere, are really valueless as human food, but for domestic animals they have for ages been used as winter fodder. During the war French horses were successfully fed on a partial diet of algæ; the new food, though quite indigestible at first, gradually became assimilable, probably through the adjuvant action of bacteria or yeasts. Prof. Sauvageau's monograph is a welcome acquisition.

Letters of Travel. (1892–1913.) By Rudyard Kipling. Pp. vi+284. (London: Macmillan and Co., Ltd., 1920.) Price 7*s.* 6*d.* net.

WITH his faculty for noting the little significant things, as well as the big and striking things, Mr. Rudyard Kipling gives us wonderful pictures of life in America, Canada, and Egypt. Some of the letters are old—they are reprinted from periodical publications—but all are fresh in human interest, because they dwell on big, essential problems. The volume is Kipling at his best, without the "tobacco and blood" in which he often indulges, and with his wealth of illustration and telling incidents of travel. These short chapters give truer impressions of the lands they treat of than all the ponderous volumes of painstaking travellers, collecting facts and arranging statistics.

Slide Rules and How to Use Them. By T. Jackson. Pp. 30. (London: Chapman and Hall, Ltd.) Price 1*s.* 6*d.* net.

THE principles upon which the construction of slide rules depend are described in this pamphlet, and numerous examples are given of the methods of use of such mechanical aids to calculation.

Electric Switch and Controlling Gear: A Handbook on the Design, Manufacture, and Use of Switchgear and Switchboards in Central Stations, Factories, and Mines. By Dr. C. C. Garrard. Second edition, revised and enlarged. Pp. xxii+654. (London: Benn Brothers, Ltd., 1920.) Price 25s. net.

No considerable alterations have been made in this work since the first edition was reviewed in NATURE of March 1, 1917. Slight modifications have been effected, and recent data in connection with high-tension gear, lightning arresters, etc., added. Two new sections, one dealing with the standardisation of switchgear and the other with automatic contactor switches, have also been inserted.

Milk Testing: A Simple Practical Handbook for Dairy Farmers, Estate Agents, Creamery Managers, Milk Distributors, and Consumers. By C. W. Walker-Tisdale. Second revised edition. Pp. 90. (London: J. North, *Dairy World* Office, 1920.) Price 3s. 6d. net.

THE recognition of the value and importance of "milk recording" is making it increasingly necessary that simple but trustworthy methods of testing milk should be published for the use of practical farmers. This need is well met by the present edition of Mr. Walker-Tisdale's little book, which has been enlarged and revised since the second edition was noticed in NATURE of August 10, 1911.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Energy of Cyclones.

THERE can be no doubt, I suppose, that solar and terrestrial radiation are ultimately responsible for the kinetic energy of the winds. The doubts expressed by Mr. R. M. Deeley in NATURE of November 11 and by Mr. W. H. Dines in the issue of November 18 can refer only to the details of the phenomena consequent on the process of transformation of the energy. The first stage is obviously the storage of energy in the potential form of air charged with heat and moisture at the surface or lower levels and cooled by radiation at high levels, especially in the polar regions, as on the plateau of Greenland or on that of the Antarctic continent, or on the sunless slopes of the Himalaya. Equally without doubt the next step is convection, the greater part of which is indicated here and there by falling rain or snow. Measurements of rainfall assure us that there is no lack of energy available for violent winds if the heat-engine is at all efficient.

The general effect of the process of convection is the development of a vast circulation in the upper regions of the atmosphere from west to east round the poles, which has its counterpart in the normal distribution of pressure at corresponding levels. That is probably most pronounced at a level of 8 km., because at that level density is equal all over the globe at all seasons of the year. Above that level, up to the level of equal pressure at 20 km. of which Mr. Dines writes, there is, on the average, a gradient of density from the equator to the pole, and below the level of 8 km. a gradient of density in the opposite direction. The layer of maximum average velocity is above the layer of maximum pressure-gradient on account of the diminution of density with height.

Below the level of 8 km. the distribution of pressure is affected by the gradient of density in a very irregular manner, because the distribution of land and water is irregular. The net result at the surface is the complicated distribution of average pressure which we find in the maps of normals for sea-level.

The maintenance of the average general circulation from west to east in the higher levels is due to the gradual convergence towards the polar areas from which the cooled air flows. That must obviously be balanced by a corresponding flow towards the equator, and as poleward flowing entails a westerly circulation, so flowing towards the equator entails an easterly one. We must, therefore, find room in the system for a body of air flowing from the east comparable at least with the circulation from the west. We find such a body of air in the great easterly circulation of the intertropical regions, which is naturally stowed away over the equator as far as possible from the centres of the two polar demi-hemispheres of influence of pressure-gradient.

These great circulations, easterly and westerly, form a normal "groundwork" of all atmospheric motion; and when Mr. Deeley and Mr. Dines write of the energy of cyclones, they are not concerned, I think, with the energy of the general circulation of the upper levels which I have described, but with the minor circulations which represent the perturbations of the major circulation.

I think myself that the convection of warm, moist air, combined with the vagaries of temperature in the lower layers, will, in the end, prove to be sufficient to explain the energy of cyclonic air-currents—whether directly or as the secondary effect of current-differences, I cannot say. Probably, in order to get a correct view of the perturbations, we ought to subtract vectorially from the observed winds the local motion of the normal circulation, or else accustom ourselves more than we do to the theoretical combination of local circulation with a general circulation.

There are four other aspects of the problem upon which we are at present almost uninformed. The first is the locality where the cyclone, which is the subject of study, was generated; just as the cyclone itself is a perturbation of the general circulation, so what we see going on over our heads is the perturbation of a cyclone which may have originated in the general circulation thousands of miles away. A cyclone is a more or less stable dynamical system which certainly travels, but changes as it travels. The second aspect is the variation of velocity of the wind with height in the general circulation and in the cyclonic area itself. The third, which is closely connected with the second, is the trajectory of convected air. This could be calculated if we knew the point from which it started and the variation with height of the current which carried it. One often reads of convected air rising *vertically*, but we know that the actual trajectories of a pilot-balloon are of very various shapes, seldom vertical, and the balloon may part company from the air which supported it at the start by a distance measured in tens of kilometres. Air in convection rises very slowly. If we set its vertical velocity at one-hundredth of that of a pilot-balloon, the convected air may be thousands of kilometres from the starting point before its upward journey is finished, and its path may be very complicated. It is possible that this conception of the slow, gradual ascent of air may have a bearing upon the cloud-formation associated with a coming cyclone, but the subject is too long for a letter.

The fourth aspect is the behaviour of the convected air with regard to its environment. The slowness of its rate of ascent is dependent largely upon the development of eddies and consequent dilution of its mass with the cooler environment. This cannot of itself arrest the upward motion, though it delays it, and, consequently, when the convected air has arrived at its ultimate level it will have carried with it some of the air which formed its environment on the way. Hence the rising air will have "evicted" a certain amount of air by its passage.

The importance of combining these aspects is at once apparent if we consider that convection in still air would simply mean a readjustment of the mass in the vertical. The potentially warm air would be at the top instead of at the bottom, and the effect of a completed process of convection would be that pressure would rise within the area of operations. But if the risen air were delivered into a rapidly moving current at the top, the air which it had "evicted" from the environment on its way would be lost to the column, and when the process was completed the air would close in from the top, the bottom, and the sides. If there were any relative motion to begin with—and there is always some—closing in from the sides must develop cyclonic circulation with a cold core. Closing in from the bottom with air colder and drier than that which began the convection would stop on account of dynamical cooling, and closing in from the top means the settling down of the air of the stratosphere and a consequent low tropopause with a column of air above it warmer than its environment.

These conditions describe what the late Lord Rayleigh postulated for superposing a vortex on a current with relative velocity of its parts. They also agree with what Mr. Dines describes as the results of his examination of actual cyclonic conditions in England. And this view of the procedure is borne out by the examination of tropical cyclones. We can form legitimate inferences from the pressure records of these visitations because the normal conditions of the localities where they occur are extremely regular. We can see by an inspection of the graph of pressure that the region covered by a cyclone has simply lost a certain part of the air which it normally possesses. In one example I estimated the loss as equivalent to 40,000 cubic km. at sea-level. Beyond all doubt or question air had gone; it was not piled up in anticyclones fore and aft, as we used to think the convected air of our cyclones must be; it was gone clean away. I suspect that it travelled away in some upper current until slowed down over the tropical anticyclone of some ocean. The story will not be complete until that surmise is verified or the correct account substituted. Hence, for the time being, I am as curious about the life-history of convective air-currents as I was twenty years ago about that of surface air-currents.

In any case, it seems to me certain that, because it carries away part of the air which it meets on its path, convection, wherever it occurs, must entail convergence, and therefore, except at the equator, it must give rise to a cyclonic circulation which may be transient or, if circumstances are favourable, permanent. The function of the stratosphere seems to be not constructive, but conservative and registrative. It protects the energy from being dissipated by "filling up," because the descent of its isothermal air is arrested by the adiabatic rise of temperature. That is, indeed, the common function of all "decks" or lids in the atmosphere, of which the stratosphere is the chief. At the same time, for an observer the stratosphere registers the locality of low pressure by the lowness of the tropopause and the relative warmth of the air column above it. It seems to be a law for the general circulation and for local circulations that as pressure diminishes in the troposphere the tropopause is lowered and the temperature of the columns above it rises.

Consequently, my view at the present time is that the energy of a cyclone is due originally to convection in a region with a suitable law of variation of velocity with height; it is guarded at the top by the isothermal condition of the stratosphere, and on the sides by the balance of pressure and rotation. It is open to slow attack at the bottom on account of the friction of its winds with the surface, and unless its energy can be maintained by additional convection it must perish. I do not think that a travelling cyclone carries its supply of rain for long distances; it probably manufactures it out of the material in the lowest levels which it has to pass over. But it uses the energy so supplied first to form a secondary, and afterwards to absorb it or to be absorbed by it.

NAPIER SHAW.

Imperial College of Science and Technology, S.W.7.

It is a well-known hydrodynamical result that, in the absence of any external stabilising influence, any surface of discontinuity of velocity in a fluid must be unstable. The effect of this instability is seen in the eddies produced in a millpond, at the margin of the entering stream. A sufficiently rapid shearing, without actual discontinuity, will produce the same effect. Most atmospheric eddies are developed in this way. In the case of differences of velocity between different masses of air at the same level, gravity is not directly available to damp any eddies that may be produced, and hence it does not seem likely to be difficult to account for eddies with their axes vertical.

Thus the origin of cyclones may well be explained on the lines suggested in Mr. W. H. Dines's letter in NATURE of November 18. It is rather more difficult to see what determines the size and intensity to which they grow. Ground friction must play its part; also, where the warm stream on the south side bulges northward, it must do so to some extent over the top of the cold air already there, and this arrangement makes for stability, and when sufficiently developed must prevent the further growth of the disturbance.

The speed of translation of the cyclone on this theory should be the mean of the velocities of the two currents, which is usually about correct. The geostrophic condition must also hold approximately, otherwise the disturbance would spread out with nearly the velocity of sound and disappear. What is not easy to see, however, is why the isobars tend to become more or less circular instead of wavy.

HAROLD JEFFREYS.

Meteorological Office, South Kensington.

I SHOULD like to express my agreement with Mr. W. H. Dines's view (NATURE, November 18, p. 375) regarding the origin of the *initial* difference of pressure which leads to the development, under the influence of the earth's rotation, of cyclonic circulation, and to state that I have often suggested that this initial disturbance may have a mechanical origin (see Quart. Journ. Roy. Meteor. Soc., vol. xliii., 1917, p. 27). At the same time it seems that one cannot, on many grounds, ignore the effect of temperature contrasts as a contributing factor in the further development and maintenance of storm energy.

To take the very fact which Mr. Dines cites, namely, the exceptional storminess of the Atlantic to the north-west of Scotland. This region is, in a most conspicuous degree, stormier in the winter months than in the summer, and it is almost one of the canons of physical geography that the excessive development of storm-energy during the cold season is favoured by the great contrast in temperature between the frostbound continents and the warm Atlantic, the individual cyclonic systems breeding not so actively over the land areas, where the general pressure is high, as over the oceanic areas, where the general pressure is low. On the other hand, during the warm season—when the temperature gradient between the oceans and the continents is reversed, but is much less steep than the winter gradient—cyclonic energy in the North Atlantic is far less powerful, whilst over the sun-heated continents storm-energy takes the form, not of extensive wind-systems, but of localised convectional thunder-systems. Furthermore, in the southern ocean, between 40° and 60° S., where there are no disturbing land masses, there does not appear, judging from the reports of navigators, to be such conspicuous seasonal difference in storminess, and this is borne out by statistics available for the Falkland Islands (Meteor. Office Geophys. Mem., No. 15). L. C. W. BONACINA.

November 19.

SIR OLIVER LODGE's suggestion and mine in NATURE of November 25 are not contradictory, but rather complementary. Work done by the alternate evaporation and condensation of moisture implies a thermodynamic cycle. Both air and aqueous vapour must, I think, play the part of working substance.

J. R. COTTER.

Trinity College, Dublin, November 26.

Luminosity by Attrition.

ALLOW me to add to the list of minerals showing this phenomenon one which I have already given in my book "Diversions of a Naturalist." It is that of corundum. I found that water-worn pebbles of corundum (so identified in the department of minerals of the Natural History Museum) gave flashes of light when rubbed together, but required for this result a heavier pressure than do pebbles of silica. The same odour as that observed when silica is used was produced.

I may also repeat here what I have stated in my book, that a spectroscopic examination of the luminous flashes of quartz pebbles gave a continuous spectrum and no detached bright lines.

E. RAY LANKESTER.

November 28.

SOME ten years ago when grinding down a thin slice of limestone under water I was surprised to find that the operation was accompanied by faint flashes of light which seemed to issue from certain spots of superior hardness; on examining the slice under the microscope it was found that these spots consisted of quartz. This led me to devise an apparatus by which the luminescence could be continuously produced and so rendered a subject for precise observation. The substance to be examined was attached to the free end of a hinged bar and adjusted so that it rested against the edge of an emery, or, still better, a carborundum wheel which was rotated by an electric motor. Of some forty minerals experimented upon no fewer than eighteen emitted light while being ground. Those that did not included all the sulphides which were examined, viz. zinc blende, cinnabar, antimonite, galena, copper pyrites, and arsenical pyrites. Iron pyrites, of course, yielded sparks, but these were not accompanied by tribo-luminescence. Almost all the silicates emitted light, *e.g.* orthoclase, labradorite, idocrase, garnet, tourmaline (one variety, another did not), epidote, zircon, topaz, and glass; several oxides, *e.g.* corundum, magnetite, hæmatite, cassiterite, quartz, and flint; light was also obtained from wavellite, apatite, celestine, and barytes. But the most remarkable results were obtained from fluorspar; all the varieties of this mineral which were examined gave light, but one in particular, distinguished by its green colour, emitted blue light, not only in great quantity, but also of such persistency that the whole periphery of the wheel was alive with it.

Curiously enough, no electrical phenomena were observed in any case; an electroscope, possibly not a very sensitive one, gave no signs even when fully exposed to the current of dust driven off during grinding.

The light emitted was in most cases white, but often coloured reddish or yellowish, and in a few instances bluish. It would be quite possible to examine (as I did) the light with a spectroscope, and after some preliminary trials I planned apparatus for photographing the spectrum. The outbreak of the war, however, put a stop to my experiments, and I have not yet had time to resume them.

November 25. W. J. SOLLAS.

Stellar "Magnitudes."

MAY I ask whether it is not time to overhaul and improve the conventional specification of stellar magnitudes?

When first introduced, on the basis of ordinal numbers, the plan was natural enough; a third magnitude was naturally inferior to a first, and a group of some twenty stars could be considered as of the first magnitude.

But when it was found possible to measure and specify magnitudes with numerical accuracy—by instrumental means not, I confess, fully known to me—so that a Variable could be said to decrease from 2·14 to 2·56, the cardinal number specification looked inverted. Moreover, magnitudes less than unity became necessary for the brighter stars, and a sufficiently bright star would presumably have the magnitude 0; a nova, for instance, might blaze up from magnitude 12 to magnitude zero, or even become of negative brightness at the height of its career. Indeed, I gather that a more recent system, of what are called "absolute magnitudes," really does involve negative numbers.

Would it not be well to reconsider the convention and devise something more convenient?

OLIVER LODGE.

Higher Forestry Education for the Empire.

THE question has been recently raised by the Government of India as to the advisability of either training the probationers for the Indian Forest Service entirely in India or confining the training to one centre in this country. The question has come to the front owing to the changes to be introduced in the administration of India, under which a larger proportion of Indians will enter the Indian Forest Service in the future, it being therefore considered desirable to train the European and Indian probationers all together. The professional forestry opinion of Indian officials, with which Prof. Troup and I agree, would appear to be unanimous in condemning the possibility of training the forest probationers in India owing to the fact that the Indian forests are, as yet, very far from having reached the standard necessary to provide students with the full practical object-lessons which are to be seen only in forest areas which have been under scientific management through one or two rotations of the crops.

The alternative suggestion is to revert to the one centre at home, which was given up when the forestry branch at Coopers Hill was closed down in 1905. This question of one centre was considered at the Empire Forestry Conference held in July last in London. The Forestry Commissioners suggested that a new centre should be created apart from the universities, and that both Indian forest probationers and the Colonial and Dominion probationers required for the Empire should be trained at the centre. It was suggested that the probationers should be selected from graduates in natural or pure science at the universities, and that these probationers should then be sent to the centre to undertake a two years' course in forestry and the applied science subjects. The conference voted in favour of this proposal. The situation of the centre, whether at one university or apart from the universities, was left in abeyance. The Indian Government representatives wished the centre to be at one university at which a forestry college should be erected for the probationers, the latter otherwise taking advantage of the university courses, laboratories, and so forth.

At the present moment the three Universities of Oxford, Cambridge, and Edinburgh are recognised by the India and Colonial Offices as qualified to train their forest probationers. The suggestion to confine the training in the future to one university would be, therefore, subsidising one university as against the other two, thus involving the waste of the capital sunk by these universities in placing their forestry schools in an efficient position. To carry out the one university centre idea it would be necessary to obtain considerable grants of money from the Indian and Colonial Governments, and it is doubtful whether one university could be thus subsidised by the Government at the expense of the others. The suggested alternative is the one centre apart from the universities.

At the end of September last the Forestry Commissioners called a meeting of the heads of the schools giving forestry training in this country.

In the discussion on the one centre proposal the heads of the forestry schools of Oxford, Cambridge, and Edinburgh were unanimous in condemning the one centre away from the university, considering that it would introduce a rigid type of teaching which would give rise to a forest officer with a narrow outlook. It would also be difficult to get first-class teachers to take up appointments in an isolated centre. The cost of the new buildings and their equipment and the outlay on salaries would also be a very heavy charge. The period of three years for the science degree and two years for the later training in forestry was also deemed too long, involving the probationers joining the Services at an unnecessarily advanced age. They were also of opinion that the complaints of the Indian Government as to the inadequacy of the training of some of their forest officers were due to the present method of selection, many probationers being selected before they had any training in forestry or knew anything of the life of a forester. It is common knowledge at the university centres training for forestry that men, finding they have no taste for the forestry subjects, change over to another side of the university at the end of their first year and while there is still time to do so. The selected forest probationer with a Government training grant is not often in a financial position to enable him to throw up his grant. Yet the proposal for the single centre away from the university is based on the continuance of this selection system. The heads of the university departments were also strongly in favour of the higher forestry education being given at the university, as the men, European and Indian alike, profited greatly by mixing with others training in other branches.

It became apparent at the Empire Forestry Conference that many of the delegates had only a superficial acquaintance with the latter-day developments in forestry education at the three Universities, which, to a great extent, have been the result of the work of the last decade.

With the view of providing for the India Office requirements that *esprit de corps* should be engendered amongst its probationers by living together, and also the practical needs of the future forest officer, which are now greater than they were, I made the following suggestion:—That the forestry probationers for India and the Home and Colonial Services should be selected from the men who had obtained a degree or diploma in forestry at the universities, and that these selected probationers should then be sent for a period of six months or a year to the new Empire Research Institute, which the Empire Forestry Conference delegates suggested should be inaugurated in this country. The probationers could be given such specialised courses as were required at this centre with a very small extra expense. The Indian probationers would thus live together during part of their training, and that *esprit de corps* required by the Indian Government would be engendered.

In the Memorandum of the Education Committee of the Conference (White Paper, Cmd. 865, p. 15) it was stated that my proposal *in re* extra specialised courses was "a tacit admission that existing courses were capable of extension with advantage." I have shown that time will not permit of an extension of the curriculum during the three years required for the forestry degree. The question of extending the degree course to four years has been under consideration at Edinburgh. The Indian Government delegates have stated that the forest officers of the future would be the *corps d'élite* of the Indian Forest Service. I fully agree with this view. To train the men to this standard will require extra specialised or advanced courses, and these can be given either at the universities or, as in my suggestion to meet the views of the Indian Government, at the Empire Research Institute.

Apart from India, the suggestion of the one centre is made on the ground that it will prove cheaper owing to the large demand for grants in aid of forestry education which have been made to the Forestry Commissioners; but in this matter of the higher training for the forest officer only three universities in this country are at present in question.

It should be possible to find out what additional funds the three universities require to maintain their schools in the highest possible efficiency, and this amount, combined with the additional sum required for the extra training of the probationers at the Empire Research Institute, would be likely to be far below the amount, to which India and the Colonial Office would have largely to contribute, which would be required to create a new isolated centre apart from the universities.

The decision on this point of the future of the higher forestry training is a momentous one, since it involves no less than the future correct management of the majority of the forests of the Empire.

E. P. STEBBING.

University of Edinburgh, October 29.

British Laboratory and Scientific Glassware.

I HAVE read with much interest the letters in NATURE of November 4 from Prof. Bayliss and Mr. Frank Wood on the subject of British glassware, and I think the whole truth lies, perhaps, between the two opinions put forward. As a manufacturer of scientific apparatus, and primarily of X-ray tubes, I have had probably as trying an experience of glass as any manufacturer since 1914.

It is well known, I presume, that prior to the war the whole of the glass bulbs and tubing used in the manufacture of X-ray tubes came from Germany, and the quality was undoubtedly very fine indeed. Since 1914 we have been obliged to depend upon glass of French, American, and English manufacture. Although by no means without merit, the products of the two first-named countries were discarded directly the English makers were in a position to give us anything at all adequate to work with, and since 1916 I think we have not used any glass whatever other than that made in this country.

At the present time the position is that a glass reasonably good for our purpose is made by at least two British firms. It works well in the flame and preserves a good appearance, but it is impossible to say that it has reached the high standard set by the German product. So far as the purchasers of the finished instrument are concerned they are not affected, because the imperfections of the British glass, where they exist, manifest themselves during the manufacture of the complete X-ray tube, and the difficulties, therefore, are entirely connected with manufacture, and not with the efficiency of the working of the apparatus which is being constructed.

It has seemed to me for a long time past to be a matter for regret that the British manufacturers could not make those small final improvements which would give us exactly the material we require instead of, as at present, stopping a little short of the ideal.

I believe there is no particular difficulty at the moment in obtaining supplies of glass from Germany, but up to now I have resisted every temptation to do this, partly on general sentimental grounds, but largely because of the enormous amount of trouble which has been taken by the two firms of which I spoke in order to produce a glass suitable for X-ray purposes. I am sure that from start to finish the profit on this undertaking must have been negligible, and there have been endless experiments and a very large amount of waste, the cost of which has fallen chiefly on the glass manufacturers themselves.

For this reason I feel that every endeavour should be made to place the British glassmakers in a position whereby they could continue to produce these special glasses, the demand for which is comparatively small, but which are, nevertheless, of the very greatest importance to scientific workers in this country. Those firms engaged in my particular branch of the electro-medical industry are always only too ready to co-operate in every possible way with the glass houses in order to secure in this country absolute independence in the matter of the supply of material.

CUTHBERT ANDREWS.

47 Red Lion Street, High Holborn,
London, W.C.1, November 25.

Heredity.

IN his letter to NATURE of November 25 Sir Archdall Reid has ably stated some fundamental biological truths concerning heredity, and with many of his statements I believe all biologists would agree. From the developmental point of view there is certainly a sense in which all characters are alike, arising as the result of the interplay of the germ and its environment, nature and nurture. In this limited sense it is doubtless beside the mark to inquire whether nature or nurture is more important, seeing that both are essential elements in any development at all. From this point of view it may be true, to cite Sir Archdall Reid's example, that there is no fundamental difference between the head and the scar; both may be in one sense germinal, and in another acquired.

But this does not go to the root of the matter, as may be most readily pointed out by referring to the latter part of the letter in NATURE. Sir Archdall Reid says: "The sole antecedent of non-inheritance is variation." The statement is true, of course, but he goes on to assume tacitly that all variations are in one category. Sir Archdall Reid recognises the fact, which Weismann emphasised, that "heritage travels down the germ-tract," and draws the "*necessary* [his italics] inference from this" that all characters of the individual are "innate, acquired, and inheritable in exactly the same sense and degree." But this is surely a *petitio principii*, for while all inherited characters may come to travel down the germ-tract, it does not follow that they all originated as variations in the germ-tract. It is surely legitimate to assume, until the contrary is proved, that new characters may arise (to use ordinary biological terms) as germinal variations or as impressed modifications of the soma which are not represented in the germ-tract. Indeed, this is the current distinction drawn between mutations and fluctuations. In the latter case the question will arise whether the modified soma may ultimately affect the germ-plasm; in other words, whether a modification or an acquired character may come to be inherited by bringing about an alteration in the germ-plasm. This is surely a legitimate inquiry. If so, it implies the possibility that the "scar" might ultimately, having become germinal, appear without the specific stimulus that is now necessary to call it forth.

R. RUGGLES GATES.

King's College, Strand, W.C.2.

The Mechanics of Solidity.

UNDER this title Mr. J. Innes (NATURE, November 18) suggests, for the benefit of engineers, that coefficients of thermal expansion are fairly closely related to hardness. His list of thirty-eight materials ranging from diamond to indiarubber is given in order of thermal expansion. No definition of hardness is suggested, and the figures, taken from three tables of "hardness," are admittedly somewhat conflicting.

Hardness, I take it, is due in part to closeness of atomic packing. Diamond, the hardest substance known, possesses also the lowest known atomic volume, while potassium, the softest element on Mr. Innes's list, has by far the highest atomic volume, *i.e.* has the loosest atomic packing.

Diversities in hardness depend also on how far each substance tested is removed from its melting point. Taking fourteen elements from the list, and assuming tests for hardness were made at uniform temperature, the order of degree-distance below melting point comes out:—Diamond, iridium, platinum, iron, gold, copper, silver, aluminium, arsenic, antimony, lead, tin, bismuth, and sulphur.

The order of hardness is: Diamond, iridium, platinum, iron, arsenic, antimony, gold-copper-silver, aluminium, tin, bismuth, and lead-sulphur. (It is probable that arsenic and antimony were tested in a crystalline state, in that respect differing from the three metals above and the four below them.)

The order of ascending coefficients of expansion is:—Diamond, arsenic, iridium, platinum, antimony, iron, bismuth, gold, copper, silver, tin, aluminium, lead, and sulphur. Here the agreement is not so close as before.

Doubtless coefficients of expansion themselves depend partly on how far the mean range of temperature from which they are calculated is removed from the melting point. For strict comparison, what are known as "corresponding temperatures" should be taken. If this is done for coefficients of expansion of gases, then the values become identical; with solids (or liquids) the coefficients would approach, but never reach, uniformity.

In practice engineers are bound to consider arbitrary temperatures which will affect their mixed materials, but a knowledge derived from comparison of physical properties at corresponding temperatures would enable them to predict special changes among the mixed material which would occur when temperatures rise or fall.

REGINALD G. DURRANT.

University College, Reading.

The Hardening of Metals under Mechanical Treatment.

IT appears from an article by Mr. Ernest A. Smith in NATURE of November 18, p. 381, that the cause of the hardening of metals under mechanical treatment is still regarded as obscure.

May I suggest, for the consideration of research associations and others concerned, that all the phenomena of plastic deformation, including hardening by distortion, are aspects of what Osborne Reynolds has called "dilatancy," and that this twentieth century is no time for random empirical experiments conducted without either guiding principles or clearly defined objectives?

Reynolds has shown that the density of a granular solid must change when the solid is distorted. There is ample evidence that distortion alters the density of metals, and no very valid reason for assigning the accompanying alteration of "hardness" (and other properties) to anything but a change in the pattern of the grains, *i.e.* to dilatancy.

Systematic experimental investigation can scarcely fail to have far-reaching results, and may even bridge the gulf between mechanics and the more exact sciences.

J. INNES.

12 Edward's Road, Whitley Bay,
Northumberland, November 22.

Tube-dwelling Phase in the Development of the Lobster.

WHILST the development of the lobster from the Schizopod stage onward to an inch or a little more is fairly well known, the great rarity of the stages between that and 3 in. or 4 in. (second year) has often puzzled marine zoologists. For instance, only once in many years has a small lobster of about 4 in. been seen at St. Andrews, and this example was tossed amidst a vast quantity of débris on shore after a violent storm. Prof. Prince, Dominion Commissioner of Fisheries for Canada, and president-elect of the American Fisheries Society, who has inaugurated many important advances in scientific fisheries work, tells me that Prof. Knight, who has been investigating the subject, finds that "after the pelagic stage the young lobster appears to frequent shallow bays and make a definite burrow with two entrances, and it sits on guard at one, but if in danger escapes by the other. It is very quick in emerging, but Prof. Knight and his assistant got 200 to 300 in a bay in Prince Edward Island. Now we know the reason of our failing to capture these very small lobsters from 1½ in. to 3 in. long. The dredge cannot secure them, yet they must occur in countless millions in our Canadian bays, since many more than 100,000,000 adults are taken in our waters for canning and the live-lobster trade in good years." Thus the rarity of the little lobsters of the stage indicated is explained.

It is interesting that the adult, as shown by Dr. H. C. Williamson, of the Scottish Fishery Board's staff, has a similar fondness for cavities, which it searches for with its antennæ, and will even turn out a weaker neighbour and seize its shelter.

W. C. McINTOSH.

Contractile Vacuoles.

I HAVE just read W. Stempel's paper, "Ueber die Funktion der pulsierenden Vacuole," to which Prof. Bayliss kindly directed my attention in NATURE of November 18, p. 376. Stempel's idea as to how the contractile vacuole works appears to differ fundamentally from my conception of its mechanism. He regards it as a preformed organ of the cell, developed to eliminate the waste products of metabolism, these products being introduced into the vacuole by the radiating canals which he endows with peristaltic action. He further postulates the existence of non-return valves between these radiating canals and the vacuole, and also of one at the point of exit of the fluid to the exterior. He considers that the evacuation of the contents is effected by the osmotic pressure in the vacuole, opening the valve and thrusting out the fluid, by the surface tension of the extruded drop, and by the pressure of the protoplasm. He does not indicate that the elasticity of the protoplasm or its tenacity enters into the mechanism. My suggestion may be summed up in the much simpler statement that the contractile vacuole is a necessary development in the protoplasmic semi-permeable gel wherever sufficient soluble material accumulates, the radiating canals being formed by the elastic recovery of the gel after rupture.

HENRY H. DIXON.

School of Botany, Trinity College, Dublin,
November 20.

Leptocephalus of Conger in the Firth of Clyde.

IN a recent issue (vol. xii., No. 2, July, 1920) of the Journ. Mar. Biol. Assoc. Mr. E. Ford, in a "Note on a Leptocephalus Stage of the Conger," gives a "summary of captures around the British Isles." To the records there given, may I add two from the Firth of Clyde?

(1) July, 1907: off Keppel Pier; 3 fms.; length, 120 mm.; depth, excluding fins, 8 mm.; a distinct row of black spots along the lateral line. Taken from the stomach of a saithe (*Gadus virens*).

(2) March, 1908; Ardneil Bay, 10 fms.; taken from the stomach of a cod (*G. callarius*); too much digested to give any details.

RICHARD ELMHIRST.

Marine Biological Station, Keppel, Millport.

Spiranthes autumnalis.

SIR HERBERT MAXWELL will, I am sure, allow me to make a little correction in his statement on p. 409 of NATURE of November 25; it was not Sir Joseph Hooker, but Sir William who in 1843 doubtfully described a solitary specimen of *Veronica tetragona* as a species of the coniferous genus Podocarpus. Oddly enough, the plant was correctly described from a flowering specimen in the same volume of Hooker's "Icones" on a later plate.

B. DAYDON JACKSON.

Linnean Society, Burlington House,
London, W.1, November 26.

Prof. Sherrington's Work on the Nervous System.

By Dr. E. D. Adrian.

PROF. C. S. SHERRINGTON, who was elected president of the Royal Society at the anniversary meeting on November 30, is well known as the leading authority on the physiology of the central nervous system. The guiding principles of his researches are to be found in his book on "The Integrative Action of the Nervous System," based on the text of the Silliman lectures which he delivered in Yale University in 1906. This book gathers up the arguments of the most important of his papers on the physiology of the nervous system, and it is safe to say that no other book in any language has had such an immediate and profound effect on our conceptions of neurology.

Prof. Charles Scott Sherrington, President of the Royal Society.

The integrative function of the nervous system has long been recognised. An animal which has attained some degree of complexity is made up of different groups of cells forming the muscles, glands, supporting framework, etc., and each group is specially adapted to carry out certain functions. If these different cell groups are to work harmoniously together, their activities must be co-ordinated with one another and with the environment of the organism, so that a change in environment will cause a response in the animal as a whole, and not merely a series of disconnected responses in the different active tissues. This integration is carried out by the nervous system, which forms a complex network of nerve-cells and nerve-fibres connected, on one hand with the sense-organs, and on the other with the different muscles and glands. A disturbance of equilibrium initiated in the sense-organs travels rapidly along the sensory nerves to the central mass of nervous tissue in the spinal cord and brain. Every moment an immense number of impulses are entering the central nervous system from the million or more sensory fibres connected to the receptive organs, and other impulses are continually passing out down the motor nerves to the muscles. Any change in the environment will modify the inflow of sensory impulses and call for some change in the activity of the animal, and the whole function of the central nervous system consists in adjusting the passage of impulses through it so that the total effect produced by the outgoing impulses to the active tissues bears an appropriate relation to the total effect of the ingoing sensory impulses. The aim of the neurologist is, therefore, to discover the means by which this adjustment of the flow of impulses is carried out. There are, roughly, three main lines of research by which the problem has been approached. The first method consists in tracing the connections of the different fibres and cell groups in the nervous system, so as to map out the path by which the impulses must travel. The second attempts to find out the contribution made by different parts of the nervous system (*e.g.* the cerebellum or the cortex) to the working of the system as a whole. Both methods have yielded information of great importance, but neither of them gives much prospect of explaining the intimate nature of the processes involved in nervous co-ordination. The third, a field relatively barren until Prof. Sherrington's work, consists in analysing the simplest activities of the nervous system by a detailed study of the reflexes.

A "simple reflex"—*i.e.* the performance of an isolated movement as the direct consequence of sensory stimulation—is generally regarded as the unit reaction of the nervous system, the behaviour of the animal being compounded out of a series of simple reflexes. But as this compounding of reflexes is the chief work of the nervous system it is naturally a difficult matter to isolate a single reaction out of the whole behaviour of the organism; indeed, in an animal which is intact we find that the response to a given stimulus may depend not only on that stimulus, but also on the total effect of all the sensory impulses which are entering the central nervous system or have entered it previously. Prof. Sherrington overcame this difficulty by isolating a part of the central nervous system, so that relatively few sensory impulses can reach it, and the reflex response to a given stimulus can be studied under approximately constant conditions. His method takes advantage of the fact that in the higher animals the great majority of sensory impulses are those which enter the brain from the special sense-organs in the head. These organs—the eye, ear, and nose—supply information about events happening at a distance, and it is on such information that the behaviour of the higher animals is largely based. For this reason the brain has come to be the most important part of the nervous system, and is in complete control of the more primitive spinal cord, which receives impulses only from sense-organs in the skin and in the interior of the body.

If the brain is cut off from the spinal cord, the latter is at first completely disorganised, but in a short time it recovers from the initial shock, and carries out simple movements of the limbs in response to stimulation of the skin or of the sensory nerve-fibres. These simple reflexes will now occur with almost mechanical regularity, because the spinal cord is isolated from the great mass of continually changing impulses which would otherwise reach it from the brain. In practice the animal is anæsthetised and the brain destroyed, usually by cutting off the entire head; as the breathing will cease, some form of artificial respiration must be employed, but with this the decapitated carcase will continue to show reflex movements for many hours. Prof. Sherrington has carried out a detailed analysis of certain of these spinal reflexes, in particular the scratching movements of the hind leg in response to irritation of the shoulder area, the withdrawal of the foot on the application of a painful stimulus, and various movements which form a part of the act of walking. He has studied also the "tonic" reflexes whereby the animal maintains a continued posture by the steady contraction of certain groups of muscles.

As a result of this method of research, he has been able to show the chief differences between conduction in the simple nerve-fibre and in the more complicated pathway through the central nervous system. He has shown how reflexes are compounded together so that two antagonistic muscles (*e.g.* the flexors and extensors of a limb) can never be called into play at the same moment, and how one reflex becomes fatigued and gives place to another so that the pattern of nervous conduction is continually changing and the behaviour of the animal varies even though the environment remains unaltered. The general principles of reflex action which Prof. Sherrington has formulated have had an immediate practical application to the problems of nervous disease and experimental psychology, and it is no exaggeration to say that his researches have opened up an entirely new chapter in the physiology of the central nervous system.

Industrial Research Associations.

IV.—The British Research Association for the Woollen and Worsted Industries.

By Arnold Frobisher.

The main object of the British Research Association for the Woollen and Worsted Industries is to promote co-operation amongst wool-using firms with the view of establishing a national scheme of research into the problems presented by the woollen and worsted industries. In the formation of the association, and in the matter of providing facilities for some work that has already been done, much assistance has been given by educational bodies, particularly by Leeds University and by the Bradford Technical College.

The scope of the work of the association includes the investigation of problems arising in all branches of the woollen and worsted industries—that is to say, the growth of wool, scouring, carbonising, carding, combing, spinning, weaving, hosiery manufacture, dyeing, bleaching, printing, finishing, and other auxiliary or related processes. As certain classes of "woollen" goods also contain substitute fibres, the investigation of these is also necessary.

One of the first duties of the council of the association has been to make a survey of the field of research which is likely to be beneficial to the industry. In this connection members of the association can be of great assistance in the framing of a thoroughly comprehensive scheme by making suggestions relating to that part of the industry with which they are intimately acquainted.

In addition to conducting the ordinary laboratory research work, provision has been made for entering into agreements with mills and works for carrying out any experiments on the manufacturing scale which have, or may, become necessary.

Considerable progress has been made towards the establishment by the association of a wool textile library, where literature relating to the industries is being indexed, abstracted, and arranged. In this connection it is hoped to work in close co-operation with the university and commercial libraries already in existence, so that there shall be a minimum of overlapping.

There is also being established a bureau of information, to which any member of the association can apply for assistance in the technical and other difficulties which he may encounter in his business. If the information necessary for the solution of his difficulty is available, it will be supplied to him; if this information is not available, the member will be able to rely on attempts being made to procure it.

Besides the scheme of co-operative research for the common good of members of the association, it is proposed to make provision for carrying on investigations at the request of individual members, at their own cost and for their own benefit. In such cases the work will be done under the supervision and control of the Director of Research, and fees will be charged to cover the cost of the investigation.

The association has purchased a large mansion in about four acres of ground, which is at present being converted into physical, chemical, and mechanical laboratories, with rooms specially adapted for photographic and photomicrographic work. A feature is being made of the possibility of modifying and improving testing machines and devices for fibres, yarns, fabrics, etc.

In the basement of the premises a room is being fitted up, the atmosphere of which can be automatically controlled as to temperature and humidity. The chamber is of sufficient size to enable experiments to be conducted within it under known and controllable conditions. At least two such rooms exist in the U.S.A. for use in testing paper and textiles, but, so far as is known, there are none in this country, apart from arrangements for *increasing* humidity. A small experimental plant is also being installed for the investigation of problems of scouring, milling, and finishing, and, as necessity arises, small-scale plants will be installed for other experiments.

As regards the programme of research, a number of "practical" problems have been formulated, among which may be mentioned the effect of "condition" (*i.e.* percentage of moisture), strength, finish, handle, waterproofing, efficiency and suitability of machinery, etc. For the solution of these problems a large amount of work is required on the ultimate properties, physical, mechanical, chemical, etc., of the fibre. Even for the commoner processes and reactions the information available is by no means complete or convenient. The early work of the association is bound, therefore, to include a great deal of former work by way of review and amplification. There are very many branches of the subject that have been worked at many times, but not completed. This particularly applies to the absence of micrographic and often of physical tests.

For example, some information is available on the swelling and elongation of fibres with water and reagents, on the manner in which the strength and elasticity of fibres are affected, and how they stiffen, soften, etc. The information at present available on those points is, however, neither sufficiently authoritative nor complete. Again, similar investigations will require to be extended to yarns, etc. Then there is the whole question of the effect of tension on the measuring and winding of yarn. Also, there is no accurate method of standardisation of qualities or descriptions in the trade, and the possibility of establishing accurate standards is to be investigated. Experiments have been going on for some time into the matter of the electrification of fibres during certain processes, and the better control of this factor would be of great commercial importance.

It is on the basis of such information as is indicated above that manufacturing processes ultimately depend. Whenever a problem in manufacturing arises, it is nearly always found that the investigation leads back to questions of a fundamental character.

Appointments of staff have already been made to cover the sections relating to physical, chemical, and mechanical problems. On the physics side an analysis will be undertaken of the ultimate physical conditions which distinguish wool from other fibres. This will lead up to a definition of the properties of any substitute. Many experiments will be made in the special humidity-controlled room, and tests carried out during and after the various processes through which the fibre passes before becoming finished fabric.

A wide field is opened up on questions of the effect on strength, elasticity, etc., of numerous reagents, and in this connection very many notes have been made of the action of various reagents, which require further investigation. It is intended to examine the many proposals for the preparation of wool substitutes, and to compare the actual properties of the resulting products.

Attention will also have to be paid to the elimination of waste in the various processes and to the recovery of grease, soaps, etc. This might be done more by way of demonstration than by investigation, as many processes are known but are not in regular use. Comparisons will be made of the detergent power of soaps and other detergents, and also of the soaps of various fats as between themselves.

On the biological side it is emphasised that there is much scope for improving the quality of British wools, and several conferences have been held at which all interested bodies and classes, including the Boards of Agriculture, sheep-breeders' associations, flock-owners, university professors, and manufacturers, were represented. It was generally agreed that by the method of selective breeding and the establishment of new crosses, etc., an improvement in wool, without loss of mutton characters, is feasible. Experiments directed to this end are already in hand in several quarters, and it is hoped that with the co-operation of the Boards and breeders substantial advances will be made.

The management of shows and individual prize-givers can also do an enormous amount to further the objects in view. It is suggested that the services of a wool expert should be retained for the more important shows, and that, in all classes where such is possible, points should be given for the wool. This expert should direct attention to its merits and defects for manufacturing.

Much work might be done in the microscopic examination of fibres and in the actual carrying-out of small- and large-scale breeding experiments, with the object of improving the wool, particularly of British breeds.

The question of large-scale experiments is not being neglected, and a site has already been purchased upon which it is proposed to build an experimental factory for investigating under actual commercial conditions, on a manufacturing scale, the many problems connected with woollen carding and spinning. This factory will be equipped with the most up-to-date machinery and staffed with the most expert labour available, with the view of conducting experiments and investigating variations of present-day methods. A well-qualified man of science will be engaged in the factory to observe conditions and keep records, and any variations in method or investigations with a view to improvements will be under his supervision. Individuals will be allowed to use the machinery for private investigations at a fee to cover the working costs. Members have also been of great assistance in allowing experiments to be made in their factories. On these questions, and, in fact, on all other topics upon which it is considered expedient, publications will be prepared, and several have already been issued.

It is clear that the work of this association overlaps or dovetails with that of other bodies in many directions. Co-operation is a welcome necessity, and has been given or offered by several Government Departments, universities, technical schools, the Industrial Fatigue Research Board, the other research associations, etc., as has already been mentioned in one or two connections.

The Education Committee of the association has submitted, after some months of very careful and detailed deliberations, a series of revised syllabuses for textile courses in technical colleges, etc., and much outside support has been given to the recommendations it puts forward. These new syllabuses are the outcome of the joint discussion of existing syllabuses and standards by heads of textile departments in the universities and colleges and by the manufacturers themselves, and they have laid the foundations of a system whereby the actual needs of industry can be put plainly before those responsible for the training of the manufacturers of the future. The committee also hopes to aid the colleges in placing students in the industries both during and after their usual technical training.

It is intended not only to award prizes to inventors, research workers, and others for work of benefit to the industries or to the association, but also to establish scholarships and to subsidise research workers and educational institutions which devote themselves primarily to the objects which are before the association.

All questions relating to these matters should be addressed to the Secretary, Torridon, Headingley, Leeds.

Obituary.

Prof. Eric Doolittle.

PROF. ERIC DOOLITTLE, director of the Flower Observatory at the University of Pennsylvania, died on September 21 at the early age of fifty years. His father, C. L. Doolittle, was professor of mathematics and astronomy at Lehigh University, and the author of a well-known treatise on practical astronomy. In 1896 the father was appointed professor of astronomy at Pennsylvania University, and the son was placed in charge of the 18-in. refractor in the Flower Observatory, which was established that year in connection with the university. The latter remained there for the rest of his life, at first in the capacity of observer and instructor, and later as professor. The refractor had been specially designed for work on double stars, and the young astronomer adopted this line of study with great energy and enthusiasm. His published work embraces some 4600 pairs, and further observations are ready for issue. In 1913 Prof. S. W. Burnham, finding himself unable to continue the work of observing double stars and discussing their orbits, paid Prof. E. Doolittle the compliment of handing over his books and manuscripts to him. The latter proved himself worthy of the trust, continuing the classification and discussion of the observations of an immense number of pairs. This work is already available in card-catalogue form, and will be published later.

Another subject in which Prof. E. Doolittle took a great interest was the computation of the secular perturbations of the planets, in which he followed a method developed by Dr. G. W. Hill. His results were published by the American Philosophical Society in 1912.

In 1917 he was called on to organise and conduct a Navigational School at Philadelphia. The work, in addition to his university duties, proved beyond his strength, and brought about the breakdown which led to his early death, cutting short a career of great usefulness and promise. We are indebted for the details given above to an article in *Science* for October 22.

NATURALISTS interested in the marine and freshwater fisheries will regret to hear of the sudden death of SIR CHARLES E. FRYER at the age of seventy. Sir Charles Fryer was born in 1850, and entered the Civil Service, at the age of twenty, as Clerk to the Inspectors of Fisheries. In 1870 he became associated with Frank Buckland and Sir Spencer Walpole, and acted as secretary during the well-known inquiry into the natural history of the marine fisheries held during that and succeeding years. He had a unique knowledge of the history of the fishing industry and of the many inquiries that have been held with regard to its administration, and, though in no sense a man of science, he was keenly interested in all fishery biological questions—particularly with regard to the river fisheries. Sir Charles was due to retire at the beginning of the war, but continued to act at the Board of Agriculture and Fisheries during 1915 and 1916. Many fishery naturalists will regret his death.

THE death, on August 20, at Mussoorie, India, of MR. FRANK MILBURN HOWLETT, at the early age of forty-three, is greatly to be regretted. Mr. Howlett represented a type of entomologist comparatively rare in this country, being particularly interested in the physiological aspects of his subject. Educated at Wymondham Grammar School and at Christ's College, Cambridge, he went out to India in 1905, and in 1907 joined the staff of the Pusa Research Institute, where he afterwards became pathological entomologist to the Government of India. Although his published papers are relatively few, they exhibit marked originality of ideas. His studies of the chemotropic responses of various Diptera attracted very wide attention, and subsequent research has demonstrated that they were the forerunners of a line of investigation which has a promising future. Mr. Howlett was also a capable athlete and a clever artist, but his activities suffered severely from ill-health during his Indian service.

THE brief announcement of the death of DANIEL PAULINE OEHLERT made to the Paris Academy of Sciences on October 11 will arouse in many British geologists a host of delightful memories, for he guided an excursion of the Geologists' Association through the beautiful country of Mayenne, as well as an excursion of the International Geological Congress. Than Oehlert and his accomplished wife, who shared his labours, no better guides could be found, for they had surveyed the district for the Carte détaillée Géologique de France. Together also they published some sound palæontological papers, chiefly on Devonian fossils. Since the death of Mme. Oehlert some years ago, Oehlert had withdrawn from active geological work, and devoted himself to the museum of his native city, Laval. He was a fine man in body and in spirit.

THE death, on November 7, is reported, in his seventieth year, of DR. SAMUEL JAMES MELTZER, head of the department of physiology and pharmacology in the Rockefeller Institute of Medical Research. Dr. Meltzer is best known for his discovery, in 1912, of an improved method of artificial respiration by which he was able to resuscitate persons whose hearts had stopped beating. Three years later he announced a successful treatment for tetanus, which consisted in the injection of a prophylactic dose of serum into the wounded patient, combined with the injection of a solution of Epsom salts into the spinal membrane, which produced complete relaxation of the muscles long enough for the serum to take effect. Dr. Meltzer was a native of Russia, was educated at Königsberg and Berlin, and went to America in 1883. At the time of his death he was president of the American Association for Thoracic Surgery and of the Medical Brotherhood.

Science of November 5 announces that PROF. ARTHUR SEARLE, Phillips professor emeritus of astronomy at Harvard University, died at his home in Cambridge, Massachusetts, on October 23. Prof. Searle, who was born in England in 1837, and graduated from Harvard in 1856, became assistant in the Harvard College Observatory in 1869. He was appointed assistant professor of astronomy in 1883, and full professor in 1887, retiring in 1912 with the rank of professor emeritus. He contributed largely to scientific magazines, and in 1874 published a text-book of astronomy.

THE death is announced of DR. H. N. MORSE, professor of chemistry and director of the chemical laboratory at the Johns Hopkins University. Dr. Morse was born in 1848, and became associate at the Johns Hopkins University in 1876. He was the author of a number of scientific papers, among which may be mentioned communications on the atomic weights of cadmium and zinc, the preparation of osmotic membranes by electrolysis, and cells for the measurements of high osmotic pressures.

THE death of MR. CHARLES MCNEIL is recorded in *Engineering* for November 26. Mr. McNeil was born in Glasgow in 1847, and was the founder of the Kinning Park Hydraulic Forge, Glasgow. He was the inventor of the well-known manhole door which bears his name, and was elected a member of the Iron and Steel Institute in 1891.

Notes.

A pleasant surprise was experienced by those who attended the meeting of the Wireless Section of the Institution of Electrical Engineers on November 24 in meeting Dr. Alexander Graham Bell, the veteran inventor of the telephone, who had been on a visit to England and to his old home in Scotland, but is now on the way to his adopted home in the United States. Dr. Bell, who stated that his connection with telephone matters had ceased some thirty years ago, expressed his pleasure at meeting that section of the electrical world which represented the future perhaps more than any other, and referred to the remarkable developments that were being made in wireless telephony, in which the telephone had gone far beyond his most sanguine conceptions of its possibilities. The *Times* reports an interesting account given at a later interview by Dr. Bell of his researches which led up to the invention of the telephone forty-five years ago. Dr. Bell had long been interested in the mechanism of speech, and in reading of the researches of Helmholtz on the nature of vowel sounds, in a language with which he was unfamiliar, he had at first wrongly concluded that Helmholtz had transmitted such sounds by electrical means. Although he soon discovered his mistake, the idea that a transmission of this kind should be possible remained in his mind, and came to fruition later when he combined two separate lines of research which he had been prosecuting on multiple telegraphy by currents of different frequencies and on recording sound-waves for the benefit of the deaf, and thus arrived at the production and application of an undulating current representing the sound-waves of speech. The freedom of his native city of Edinburgh was conferred upon Dr. Bell on Tuesday, November 30.

Prof. W. H. Eccles, chairman of the Wireless Section of the Institution of Electrical Engineers, in his inaugural address at the meeting referred to above, gave a masterly review of the progress of research during and since the war on the thermionic-valve tube, which originated out of the Fleming oscillation valve, and had become, in its three-electrode or "triode" form, the basis of all modern wireless telegraphy. He reviewed some of the interesting papers which had already described the intensive development of the subject under the stimulus of war, but not the least interesting part of his address was his account of some of his own extensive researches in the investigation of the interdependence of the currents and voltages in the various circuits connected to the grid, anode, and filament of the tube, with a view to greater certainty in the design of such tubes to fill the conditions required with a maximum of efficiency. Owing to the number of variables involved, he had extended his treatment from the ordinary plotting of curves in two dimensions to the manufacture of a series of clay models of surfaces in three dimensions, which should be of very great value in elucidating the properties of these tubes. Other scientific questions raised by phenomena met with in wireless telegraphy which Prof. Eccles dealt with included the diurnal variations in the ionisation of the upper layers of the atmosphere, which he suggested might possibly account for certain remarkable discrepancies in the results of wireless direction-finding apparatus at particular times in the day by causing a rotation of the plane of polarisation of the received waves.

At the opening meeting of the Röntgen Society, held on November 18 at University College, it was announced that the first award of the Mackenzie Davidson medal had been made to Dr. F. W. Aston. The award, which was instituted to perpetuate the memory of the late Sir J. Mackenzie Davidson, is made by the council of the society for the most noteworthy contribution to its meetings during the session on some subject bearing upon radiology. Dr. Aston's paper was read on June 1, and appears in the current issue of the Journal of the society under the title "Positive Rays." It deals with the remarkable series of isotopes among non-radio-active substances, which Dr. Aston has been investigating for several years.

The twenty-sixth annual congress of the Royal Institute of Public Health, which will be of an international character, will be held next year in Geneva, on the invitation of the University, from Tuesday, May 10, to Monday, May 16, inclusive. Further particulars can be obtained from the Secretary, 37 Russell Square, W.C.1.

The British Silk Research Association has been approved by the Department of Scientific and Industrial Research as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. The secretary of this association is Mr. A. B. Ball, Silk Association of Great Britain and Ireland, Inc., Kingsway House, Kingsway, W.C.2.

The Government of the Czecho-Slovak Republic has established, under the Ministry of Education, a Weather Bureau in Prague, to do for that country the work formerly done at the meteorological central stations of Vienna and Budapest. The new bureau will extend the meteorological service formerly conducted in connection with the K. k. Sternwarte, Prag-Klementinum (Astronomical Observatory). The director, Dr. Rudolf Schneider, is anxious to receive for the library of the bureau all the reports of observations and meteorological publications formerly sent to the Sternwarte, and he will be glad to send to other meteorological stations and offices publications of his bureau in exchange.

For some time past the National Union of Scientific Workers, the Institute of Chemistry, and the British Association of Chemists have had under consideration the matter of income-tax assessment of scientific workers. After several discussions it was agreed unanimously to prepare a memorial to the Lords of the Treasury setting out under six distinct headings a claim for abatements. The memorial was forwarded to scientific societies and to research and technical staffs of various institutions and science faculties of the universities of the United Kingdom, many of which associated themselves with the memorial. It was then sent to the proper authorities. The secretary of the joint committee has now been informed that the Chancellor of the Exchequer has arranged for the Commissioners of Inland Revenue to meet a deputation of scientific workers on Friday, December 10, to afford them the opportunity of supporting their claims.

THAT excellent institution the Children's Museum of Brooklyn has sent us an issue of its *News*, which is devoted to an account of the museum's efforts to Americanise the children drawn to New York from all the countries of Europe. The museum, it is claimed, can supply that which the teacher cannot provide, namely, an American background for the intellectual life of the child. This is effected by helping the pupils to visualise incidents in the lives of past Americans through the numerous models and objects of historic interest in the museum. By contact with these concrete exhibits the abstract knowledge provided in school becomes more real to them, and a personal link with the country's past is forged in the mind of each child. The influence of the museum is even wider than mere Americanisation, for "the person whose intellect is overtrained to the neglect of the senses is perhaps a greater menace to the community than the illiterate."

THE fourth annual Report of the National Research Council of the United States of America consists of 68 pages, and shows that a large proportion of the programme of the Council is now in operation. The funds are provided mainly by the Carnegie Corporation of New York, the Rockefeller Foundation, the General Education Board, and the Commonwealth Fund. Its purpose is to promote research in the mathematical, physical, and biological sciences with the object of increasing knowledge and contributing to the public welfare. One of its thirteen divisions deals with foreign relations, and represents the Council at the meetings of the International Research Council. Another deals with the physical sciences, and already has research committees on atomic structure, celestial mechanics, X-ray spectra, electrodynamics, photo-electricity, etc. The engineering division has committees on fatigue in metals, heat treatment of steel, pyrometers, highways, etc. The chemistry division has committees on synthetic drugs, colloids, ceramics, etc. The Council is to be congratulated on the speed with which it has got to work.

WE have received a copy of the appeal issued by the University of Birmingham for 500,000*l*. The present financial position, as set forth in the circular, is indeed critical. The increase in cost of administration and maintenance, coinciding with an increased demand on the capacity of the University—each additional student costs about three times as much as he contributes—has made bankruptcy the only alternative to a large addition to its resources. Among the objects of the appeal the first place is rightly given to the improvement of the salaries of the teaching staff, especially of the non-professorial section. Provision has also to be made for the enlargement of existing departments to cope with the demands made upon them. It is further pointed out that additional chairs are required in many subjects (*e.g.* mathematics, physics, chemistry, engineering, and biology) and that increased facilities for research are urgently needed. There is, moreover, an insistent and growing demand on the part of industrial workers for extra-mural work, and classes have been created for trade unionists, in which special instruction is given in English literature, economics, and modern history, in co-operation with the Workers' Educational Association. The provision of hostels for men students is also very desirable. Finally, it is urged that grants or gifts to the University will in all probability secure an equivalent from the Government. A first list of contributions shows promises amounting to more than 250,000*l*., of which nearly one-half is given by representatives of the petroleum mining industry for a petroleum mining endowment fund. We sincerely hope that further lists may show that the Birmingham and Midland district is alive to its responsibilities in the matter and that the desired sum may be raised.

IN the Museum Journal of the University of Pennsylvania (vol. xi., No. 1, March, 1920) a valuable article, with excellent illustrations, is published describing a collection of "fetish" figures from equatorial Africa. The word "fetish" is now suspect among anthropologists, as its meaning has been unreasonably extended. At the same time, the great majority of these wood carvings have undoubtedly some connection with the religious magic of the negro, and among the special group of the Bakuba-Baluba peoples in the South-Western Congo region the best and least contaminated negro art is found among a race which possesses a more highly developed system of cults, religions, or magico-religions than any other Congo people possessing such a high degree of culture.

THE *Archives of Radiology and Electrotherapy* for October (No. 243) contains the continuation of a sketch of the history of electrotherapy by Mr. H. A. Colwell. The period dealt with is from 1800 to 1879, and the apparatus of various inventors is described and figured, such as Golding-Bird's contact-breaker (1838), Neef and Wagner's and Benedict's induction coils, Piscii's magneto-electric shocking machine (1832), and various portable batteries. Contact-breakers worked by an assistant were in use as late as 1849. The account, which is a very interesting one, is to be continued.

Medical Science: Abstracts and Reviews for November (vol. iii., No. 2) contains a critical review of the cancer problem, particularly of work done during the last twenty years. In England and Wales one woman in eight and one man in eleven above the age of thirty-five years dies of cancer. Acquired immunity to transplanted cancer in the mouse and rat can be produced by means of *living* cancer-cells. Altmann's granules are absent from the cells of malignant growths. The blood and tissues of cancerous persons contain more potassium than normal, and human cancerous material contains more radium than normal. Considerable space is devoted to the various methods of treatment of cancer, which it is concluded must proceed along the lines of a judicious combination of surgery and irradiation.

IN the Museum Journal of the University of Pennsylvania (vol. x., No. 4, December, 1919) we have an account of head-hunting among the Jivaro tribe, occupying a large territory on the eastern slope of the Andes in the Republic of Ecuador. They have been called cannibals, but they never eat any part of the human body. The mummified heads of their enemies are the most esteemed war trophy, because the head must be present at the victory feast which the hero is expected to give. The head must be preserved, because it requires many months to clear a field and grow yucca and bananas to provide food for the numbers attending the feast. The head is fixed on a staff and paraded, with a tribute to the valour of the slayer, before the assembled tribesmen. After this an orgy of eating and drinking continues for days until all the supplies are exhausted.

THE way in which one part of an organism regulates the activity of another is a problem of supreme interest in biology. In unicellular organisms the transmission is local, but in multicellular organisms conduction may be by the circulating fluid or by nerves. Conduction by nerves is the main theme discussed by Prof. R. S. Lillie in an address on "The Nature of Protoplasmic and Nervous Transmission" (*Journ. Physical Chemistry*, vol. xxiv., 1920, p. 165). The propagated disturbance in nerves cannot be a chemical transport because of its rapidity. A nerve-impulse is always accompanied by an electrical change of potential of sufficient voltage to stimulate another nerve. The hypothesis is advanced that the current of action stimulates a contiguous portion of nerve, thus accounting for the transmission of the impulse. The negative electrical potential at an active part of the nerve is short-circuited through the surrounding electrolyte solution, so that the current passes in at the active portion of the nerve and out at an inactive part. The inactive portion of nerve is thus stimulated as if by the cathode of an external stimulating circuit. The time required for the potential to reach its maximum is 0·001 of a second, and, assuming that the current is effective over a length of 3 cm., the rate of conduction would be 30 metres per second; this is the value obtained for a frog's nerve at temperatures of about 15° C. The propagation of the nerve-impulse is compared to "passive" iron and its activation, the two processes having much in common.

THE newly established French Office Scientifique et Technique des Pêches maritimes is issuing a series of Notes et Mémoires, and No. 2, "Le Merlu," by Dr. Ed. le Danois, has just been published. It is a summary of our knowledge of the life-history of the hake. Of late years this has become one of the most important of marine food-fishes because of its wide distribution. Compared with our knowledge of other fishes, very little is known as yet of the general biology of the hake, and it has been proposed (by the International Council for the Exploration of the Sea) to institute investigations (to be carried out by France, England, and Ireland) on this and other fishes inhabiting the south-western European area. The paper under notice is therefore opportune. It is almost entirely a *résumé* of the research which has been carried out on the hake by the various fishery authorities, and it is accompanied by a series of sketch-charts representing the seasonal distribution of the fish, the localities of fishing, the spawning places and periods, and the migrations. A summary of the European commercial hake fisheries is also given. The author discusses the causes of migration, and suggests a factor which seems to be new (though this is difficult to say, for no references to published work are given). Food is not a factor, for that taken by the hake is variable, and during its spawning periods (when its migrations are most noticeable) it does not eat at all. Its migrations cannot be correlated with any seasonal changes in the plankton. On the other hand, changes of temperature throughout the year either enlarge or restrict its range of distribution, and variations of salinity are also factors. The body of the young hake is relatively dense, but as the genital organs mature the density diminishes. This leads to a greater energy requirement in relation to the locomotion of the fish, and it seeks water of lower salinity or higher temperature, or both. Thus, by reason of "the principle of least effort," the hake migrates into shallower, warmer, and less saline waters as its breeding season approaches.

A CHADWICK public lecture was delivered by Prof. J. B. Farmer in the lecture hall of the Medical Society of London on November 5, the subject being "Some Biological Aspects of Disease." The lecturer pointed out that it was now a recognised fact that co-ordinated growth in an organism leading to the development of a particular form depended on the serial or sequential nature of the reactions which went on in its cells and tissues. Recognition of this was essential to a proper appreciation of the larger problems of health and disease. By the consideration of examples, taken chiefly from the plant-world, it was shown how differences in chemical or physical environments produced definite changes in the organism, though close analysis of the facts emphasised the essential point that it is only when environment was able to interfere, as it were, with the protoplasm itself that response of this kind was obtained. The effects of the temporary isolation of parts of the body from the material influences exerted by adjacent parts might result in a permanent loosening of the ties which previously had knit the constituent cells into a coherent organism, while the union of parts hitherto separate sometimes led to the formation of a synthetic new organism; lichens are striking examples of this. The consequences of the mutual relations established between parasite and host were dealt with, particularly with reference to the abnormal growths which can be traced to substances injected by parasitic animals. Prof. Farmer then passed on to discuss briefly the abnormal growths or neoplasms which originate as the result of obscure changes taking place within the cells themselves. The essential features of malignant growths were described and the outline of a plan of research for the advancement of our knowledge of the causes of cancer was suggested.

THE proceedings of the sixth annual Indian Science Congress, which was held in Bombay on January 13–18, 1919, have been published in the Journal and Proceedings of the Asiatic Society of Bengal, vol. xv., No. 4. The volume contains full reports of the presidential address delivered by Sir Leonard Rogers, an abridged version of which appeared in NATURE of May 29, 1919, and of the presidential addresses delivered to the various sections. The latter are followed by brief abstracts of the other papers read at the meeting.

A GAZETTEER of streams of Texas has been compiled by the United States Geological Survey and published as Water Supply Paper No. 448. Source, length, and topographical details are given in all cases, while in that of the more important streams other information, such as season of greatest flow, gradient, and precipitation in the basin, is added. The work is based on the best maps available, supplemented by personal reconnaissance. References are given to sheets of the topographic survey. The addition of a map to the volume would have rendered it more useful for reference.

WE learn from the *Geographical Journal* for November that Col. P. H. Fawcett is planning to return to his work of exploration in Western Brazil east of the Bolivian frontier. The expedition, which has the active support of the Brazilian Government, will include, besides Col. Fawcett, two Brazilian officers and Major Lewis Brown, of the Australian infantry. The investigation of the Indian tribes is one of the chief objects of the expedition. Cartographical work will be governed by astronomical observations and based for its longitudes upon the courses of the main rivers as determined by the work of the Rondon Commission.

THE potentiality of Australia for white settlers is discussed by Dr. Griffith Taylor in an article entitled "Nature *versus* the Australian" in *Science and Industry* for August. After a discussion of the amount and variability of rainfall in Australia, Dr. Taylor divides the country into seven regions based on rainfall, in terms of which agricultural and pastoral production can be classified. Farming and close white settlement generally are, and, he contends, will be, confined to three of these regions, which embrace the Riverina, Victoria, Tasmania, eastern Queensland, the north-east of New South Wales, and "Swanland" in Western Australia. The distribution of minerals, especially coal, will in time result in dense population irrespective of agricultural potentiality, but in Australia the coalfields occur in the regions favoured by climate, and so tend to more centralisation of population. Dr. Taylor is not hopeful of white settlement in tropical Australia, and gives adequate climatic reasons for his opinions. The paper concludes with a tentative map showing the habitability of the globe. In the southern hemisphere south-eastern Australia and New Zealand alone are indicated as areas with a potentiality in white settlement of more than 125 per square mile.

THE Department of Agriculture of the Union of South Africa has recently issued a report (Bulletin No. 4, 1920) on investigations in the wool industries of Great Britain and the United States of America with a view to the betterment of the industry in South Africa. An interesting survey is made of the kinds and qualities of wool and its substitutes, and a useful comparative statement gives the countries to which South African wool was exported from 1913 to 1919. Next to Great Britain, Germany was the largest purchaser of South African wool previous to the war, and since then her place has been taken by America and Japan. Very informative tables are appended showing the world's wool production and the estimated world's wool stocks in the 1919–20 season. While the usual annual supply of the world is estimated at 2,700,000,000 lb., there was available in 1919–20 for consumption by manufacturing countries as much as 4,200,000,000 lb. The defects of South African wool are gone into in detail, and useful suggestions are made with a view to their elimination. Great care appears to have been taken in estimating the capital expenditure required to build and equip factories for specialisation in the various branches of manufacture of woollens and worsteds, the expected output from certain machines is properly tabulated, and the cost of labour is shown for England, France, the United States, Germany, and Austria, while the cost of running and maintenance of plant is dealt with systematically.

UNTIL recently the process of the melting and casting of metal in a brass mill was very similar to that practised 240 years ago. As a rule, small crucibles having a maximum holding capacity of about 300 lb. were used. The advent of the electric furnace, however, is now rapidly revolutionising the industry. In one type the heat of the electric arc is used, and in the other—the induction type—the metal is melted by the electric currents induced in it. An interesting account of the latter kind of furnace is given by Mr. G. H. Clamer in the Journal of the Franklin Institute for October. Official tests show that about 10 lb. of two-to-one yellow brass are brought to the casting temperature (2000° F.) per electric unit expended in the Ajax-Wyatt furnace. The metal is melted directly by the Joule effect, the electromagnetic forces keeping it circulating. A very interesting induction furnace has been invented by Dr. Northrup. Instead of using alternating current of the ordinary commercial frequencies, he uses currents having frequencies of 10,000, similar to those sometimes used in long-distance radio-telegraphy. In this case no resistance column of molten metal is necessary. The metal contained in a plain cylindrical crucible is brought to any required temperature by the induced eddy currents. These furnaces are suitable for very high temperature melting, such as is required, for instance, by alloy steels and precious metals.

Under the comprehensive title of "Sterilisation of Water by Chlorine Gas" a paper by Capt. J. Stanley Arthur was read before the Institution of Mechanical Engineers on November 19. The part of the paper dealing with the general aspect of the subject adds little or nothing to our knowledge, and contains statements which, to say the least, are still debatable. For example, the author states that water treated with chlorine gas is less liable to an objectionable taste than when treated with bleaching-powder, and, further, that any taste so imparted can readily be removed by the addition of sulphur dioxide. Other experimenters have found that there is little or no difference between bleaching-powder and chlorine gas as regards taste, and also that some tastes produced by chlorination are absolutely unaffected by the further addition of sulphur dioxide. Also, no mention is made of the pioneer work on chlorination of Houston and McGowan at Lincoln in 1905 or of any of Houston's later work on the subject. The greater part of the paper consists of the detailed description of an American device for accurately administering the dose of chlorine and its adaptation for the purpose of sterilising the water-supply to the troops during the war. These descriptions are very clearly stated and well illustrated with careful drawings. No other types of chlorinators are described, although there are others equally efficient now on the market. The paper concludes with a warm tribute to Sir William Horrocks for his work on water purification for the Army, and is further evidence of the great part played by the sanitary section of the R.A.M.C. in winning the war; it is probable, however, that Sir William and his colleagues would be the first to acknowledge their indebtedness to others not mentioned in Capt. Arthur's paper.

The latest catalogue (No. 407) of second-hand books offered for sale by Mr. F. Edwards, 83 High Street, Marylebone, W.1, is devoted to botany, ranging over the subjects of agriculture, gardens, orchids, trees, fruits, fungi, lilies, and roses. It should be of interest to many readers of Nature. Many choice and rare works are listed, among them several herbals, a complete set of the *Annals of Botany*, *Curtis' Botanical Magazine*, 1787–1915, and Sir J. D. Hooker's "Botany of the Antarctic," 6 vols.

We are informed that the office of the Assistant Commissioner of Forestry for England and Wales (Mr. Hugh Murray) is now situated at 30 Belgrave Square, London, S.W.1. The headquarters of the Commission remains at 22 Grosvenor Gardens, London, S.W.1.

Our Astronomical Column.

The Leonid Meteoric Shower.—Mr. Denning writes that on November 15 and 16 the Leonids returned in moderate numbers. Mr. C. P. Adamson, observing at Wimborne, Dorset, watched the sky during a period of ten hours, and saw thirty-three Leonids out of a total of ninety-eight meteors recorded. The radiant point was placed at $150°+22°$, and the display furnished objects of the usual swift and streak-leaving character.

Miss A. Grace Cook, at Stowmarket, also witnessed the return of the meteors on the same nights and determined the radiant in precisely the same position as Mr. Adamson. Mr. A. King made observations from Lincolnshire, and on November 15, during a watch of three hours between 11h. 18m. and 14h. 37m., saw thirty meteors, of which nine were Leonids directed from a radiant at $152°+23°$. Other showers were seen from $63°+22°$ (five meteors), $107°+35°$ (seven meteors), and $116°+49°$ (five meteors) at the middle of November.

The reappearance of the Leonids adds another link to the chain of past observations, which prove that this stream of meteors is visibly continuous throughout the entire orbit, and that it may be viewed every mid-November when the prevailing atmospheric conditions are favourable.

Radiation Pressure on Electrons and Atoms.—Mr. Leigh Page discusses this subject in *Astrophys. Journ.* for September. It was formerly concluded that radiation pressure reached a maximum for particles of diameters comparable with a wave-length, and fell off rapidly for smaller particles. The present paper shows that this result neglects resonance, and that the radiation pressure on an atom "depends on the intensity of that portion of the incident radiation which has a frequency equal to the natural frequency of the oscillator." It is deduced that the pressure of solar radiation is greatest on an atom which has a resonant frequency in the infra-red near to wave-length 9000 Å., being within one-third of this maximum value for the range 4000 Å. to 28,000 Å. The pressure may be further increased if the atom has more than one resonant frequency.

It is shown that in certain circumstances the repulsive force may be thirty times that due to gravitation. It thus seems sufficient to explain most of the phenomena of comets' tails, and removes the difficulty formerly felt, namely, that the spectroscope shows the presence of certain gases in the tail, for the molecules of which the pressure was thought to be negligible. The author states that since writing the paper he has found that some of his conclusions were published by M. Gouy in 1913 (*Comptes rendus*, vol. clvii., p. 186).

Perturbations in a Stellar Orbit.—There are not many cases where perturbations in stellar orbits can be observed with any degree of accuracy. Mr. J. S. Paraskevopoulos examines the case of 13 Ceti in *Astrophys. Journ.* for September. This is a visual binary with a period of 6·88 years, while the brighter star is a spectroscopic binary with a period of 2·0818 days. The eccentricity of the orbit of the visual pair is 0·725. The author has remeasured a number of spectrograms taken at the Yerkes Observatory between 1906 and 1913, deducing separate orbits at three different epochs. These show that the period is shorter by 1/200 day at apastron of the visual companion than at periastron, this being analogous to the period of the moon at aphelion and perihelion. Motion of the line of apsides is well established. It is concluded that the mass of the visual companion does not fall far short of, and may exceed, that of the spectroscopic pair. Taking the parallax as 0·050″ (J. A. Miller), m/M becomes 1·32.

The system 85 Pegasi is referred to, in which Prof. G. Van Biesbroeck deduced that the mass of the brighter component was only 0·36 of that of the whole system.

Anniversary Meeting of the Royal Society.

AT the anniversary meeting of the Royal Society, held on Tuesday, November 30, the report of the council was presented, and the president, Sir Joseph Thomson, delivered his valedictory address. Sir Joseph succeeded Sir William Crookes in the presidential chair in 1915, and has therefore served through as difficult a period as any in the history of the society. What the society and the nation owe to his activity and genius can be understood only by those who have been associated with him on some of the many committees or other bodies constituted during these troublous years to maintain national life and security. All the resources of British science have been organised and rendered available for public service with these ends in view; and a record of the aid thus afforded to the country by the society during Sir Joseph Thomson's presidency would afford convincing evidence of the value of science to the nation and of the patriotic spirit of scientific workers. Sir Joseph is succeeded as president by Prof. C. S. Sherrington, Waynflete professor of physiology in the University of Oxford, a short account of whose notable work on the central nervous system appears elsewhere in this issue.

State Aid to Science.

Several important matters are referred to in the report of the council of the society. In March of last year a memorandum on State aid to science through grants to universities and to the Royal Society was submitted to the Lords Commissioners of H.M. Treasury. The memorandum contained the following statement of the relation of purely scientific work to human progress:

"The promotion of research in pure science without regard to its industrial applications is important:

"(1) Because science is not merely the handmaid of arts, but depends on study which elevates a nation, and wherein the natural curiosity of the mind finds exercise and satisfaction.

"(2) Because the history of science shows that many of the discoveries which have revolutionised old industries, and established new ones, have been made by those whose aim was simply to extend our knowledge without any reference to practical applications.

"The encouragement by the nation of research of this kind must, in our opinion, follow different lines from those which may be adopted with advantage for promoting research in applied science. Any direct endowment of research, to safeguard it from abuse, involves something in the nature of a report at regular intervals which should be submitted to experts for their approval. Research in pure science is inevitably intermittent, and may be gravely injured if required to show results at any particular date. Its ideas are often novel, and so far opposed to existing views that they may not obtain the approval of men with long-established reputations, such as those to whom the reports would naturally be submitted.

"A large part of this pioneer work in science has in the past been done in the universities, and this is likely to be true to a still greater extent in the future. We consider, therefore, that the best way of promoting research in pure science would be to put the universities in such a position that they can provide for their teachers adequate salaries, appliances, and time for research. This will involve increased grants to the universities. These will be necessary even if the universities are merely to maintain their output of research at the present level, owing to the greatly increased expense of the upkeep of a laboratory due to the higher wages and cost of material. But in our opinion research in our universities ought to be greatly extended and not merely prevented from decreasing. A substantial increase in the grants to universities and university colleges is therefore required.

"For these reasons we are agreed that for the advancement of science the first need is to make adequate provision for the promotion of science at the universities."

The purpose to which the Government grant to the Royal Society is applied includes: (1) Grants for providing apparatus and materials for researches approved by the Government Grant Committee. (2) Grants in aid of scientific expeditions, such as those for observing eclipses or for the exploration of the polar regions. Grants have also been made separately by the Treasury to international undertakings, such as those to the International Geodetic Association (300*l.*), the Seismological Association (160*l.*), and the Metric Convention (200*l.*–300*l.*), which in future will be organised by an International Research Council formed under the authority of the principal academies of the countries concerned.

In response to the council's memorandum the Lords Commissioners increased the annual grant for research from 4000*l.* to 6000*l.*, and, although they were not prepared to make a separate annual grant for scientific expeditions and stations, a non-recurrent grant of 5000*l.* was included in the Parliamentary estimate for the year. With regard to international research, they proposed the provision of an annual grant of 2000*l.*, provided the society would "assume responsibility for the payment of subscriptions for all classes of international research." After correspondence this responsibility was somewhat qualified, and the provision proposed accepted.

Rudolf Messel Bequest.

By the terms of the will of the late Dr. Rudolf Messel the Royal Society becomes entitled to four-fifths of the residuary estate. It is estimated that the value of the bequest will be, in the first instance, not less than 70,000*l.*, ultimately increasing to about 90,000*l.* The clause of the will governing the disposal of the residuary estate is as follows:—"I give four of such parts to the Royal Society, Burlington House, and the remaining part to the Society of Chemical Industry, Broadway Chambers, Westminster, and, without imposing any trust or obligation, I think fit to set forth my desires with regard to the fund given to each of these societies as follows: (i) The fund should be kept separate from the other funds of the society and be known under my name or otherwise as the society may think fit. (ii) The capital of the fund should be kept intact. (iii) The society should apply the whole of the income of the fund in such manner as it may think most conducive to the furtherance of scientific research and such other scientific objects as the council of the society may determine, and should not apply any part of the income for such charitable objects as the granting of pensions and the like. . . ."

It must not be supposed, however, that the society is relieved of financial anxiety by this generous bequest or by the State grants referred to above. The bequest has to be kept separate from the general funds, and the society acts solely as administrator of the Government grants. On account of increased expenses, a heavy deficit on the year's working had to be faced; and the council points out that even if the whole income from the Messel bequest were used to defray the cost of publications, there would still be a deficit. The annual subscription of fellows has been raised and steps have been taken to reduce expenditure wherever possible, yet the situation is still serious, and further financial provision must be secured if the society is to maintain its activities.

Presidential Address.

In his presidential address Sir Joseph Thomson referred to distinguished achievements of fellows of the society lost by death during the year, and to the admission of the Prince of Wales as fellow on January 22 last. He directed attention to the large increase in the cost of publishing the Proceedings and Transactions, and suggested that something might be done to make the papers published by a society as accessible to the scientific public as those published in other ways. "I think," he added, "some improvement in our sales might possibly be effected and science benefited if there were some organisation, private or otherwise, for the sale of separate papers. The formation of a library, to include all papers on one of the great branches of science, such as physics, requires a longer purse and more bookshelves than most are able to afford. But there are many, I think, who would like, and could afford, to form a fairly complete collection of the literature of one or more of the subdivisions of the subject in which they are especially interested—say, for example, electrical waves or low-temperature research. As lists of the papers in these subdivisions are published at regular intervals by various agencies, it ought not to be difficult to arrange for the distribution of the separate papers if these could be obtained from the societies."

The Medallists.

The Copley medal is awarded to DR. HORACE T. BROWN in recognition of his work on the chemistry of carbohydrates, on the assimilation of atmospheric carbon dioxide by leaves, and on gaseous diffusion through small apertures. As was the case with Pasteur, so with Horace Brown, problems and difficulties arising out of a branch of the fermentation industry supplied the incentive to investigations which are of fundamental importance in chemistry and botany. His work began in 1871 with the investigation of one of the diseases of beer, and includes an exhaustive study of the chemistry of starch, the germination of the barley grain, and the changes occurring in the green leaf during photosynthesis.

The Rumford medal is awarded to LORD RAYLEIGH, who is distinguished for his researches into the properties of gases at high vacua, and whose work has opened the way to many valuable investigations. Some years ago Lord Rayleigh made a number of interesting observations on the afterglow in various gases noticeable after the cessation of an electric discharge, and these led in 1911 to his Bakerian lecture on "The Afterglow of Nitrogen." The investigation thus started has proved the subject of much of his recent work, and in a series of most valuable papers he has studied the properties of the gas in which this afterglow is visible.

A Royal medal is awarded to PROF. GODFREY HAROLD HARDY, who is well known both in this country and on the Continent for his researches in pure mathematics, particularly in the analytic theory of numbers and allied subjects. Immediately after taking his degree at Cambridge Prof. Hardy engaged in a series of researches on the theory of functions of a real variable, from which results of the greatest importance and generality were obtained, at first by himself alone and later in collaboration with Mr. J. E. Littlewood. Among the more important researches of which Prof. Hardy is sole author may be mentioned papers on Dirichlet's divisor problem, on the representation of numbers as the sum of n squares, on the roots of the Riemann ζ-function, and on non-differentiable functions.

A Royal medal is awarded to DR. WILLIAM BATESON, who is universally recognised as a leading authority on genetics, and has done more than anyone else to put that branch of inquiry on a scientific basis. The work that stands to his name is, however, but a fraction of that which he has inspired wherever biological research is prosecuted. In conjunction with Prof. Punnett he worked out in detail one of the earliest cases of sex-linked inheritance. Peculiar association of genetic factors in gametogenesis had previously been discovered by the same authors and described under the terms "coupling" and "repulsion." In 1911 they published two papers which proved that these phenomena are part of a more general phenomenon of linkage, the orderly nature of which was pointed out. Since these papers appeared the phenomenon has been shown by various workers to be widespread in both animals and plants. Three papers by Bateson and C. Pellew record a discovery of high interest and importance, viz. that the germ-cells of the same plant may vary in their genetic properties. It is further pointed out that the variation proceeds in an orderly way from the base of the plant to the apex. The conception is a novel one, and is bound to have great influence on the development of genetical theory.

The Davy medal is awarded to MR. CHARLES THOMAS HEYCOCK, who, in collaboration with the late Mr. F. H. Neville, published a remarkable series of papers, all characterised alike by great experimental skill and originality, as well as by precise, yet simple, mathematical treatment. The molecular complexity of metals when dissolved in other metals, the composition and constitution of binary and ternary alloys, and the part which the eutectics play during the cooling of a complex alloy were clearly revealed, not only by freezing-point methods, but also by a most ingenious method of chilling, as well as by etching by means of many new reagents. These researches have not only added very greatly to our theoretical knowledge and conceptions, but have also been of the greatest importance to industrial metallurgy in many directions.

The Darwin medal is awarded to PROF. ROLAND HARRY BIFFEN, who has worked out the inheritance of practically all the obvious characters of wheat and barley. Perhaps his best-known work is that on the inheritance of strength in wheat and on the inheritance of susceptibility and resistance to yellow rust in wheat. Biffen's activity is not by any means to be measured by his published work. Two of his new wheats—Little Joss, which owes its value to its immunity from rust, and Yeoman, which combines high yield with first-class baking quality—are among the most popular wheats in the country, and together account for something like a third, or even a half, of the wheat crop of England.

The Hughes medal is awarded to PROF. OWEN WILLIAMS RICHARDSON for his researches on the passage of electricity through gases, and especially for those relating to the emission of electrons from hot bodies, a subject which Prof. Richardson has made his own and christened "thermionics." The subject is of great industrial as well as of scientific importance.

The anniversary dinner of the society was held on Tuesday at the Royal Palace Hotel, Kensington.

The Mackie Ethnological Expedition to Central Africa.

THE REV. J. ROSCOE, the leader of the Mackie Ethnological Expedition to Central Africa, has recently returned to this country after an absence of more than eighteen months. The expedition, which was made possible by a generous donation from Sir Peter Mackie, placed at the disposal of the Royal Society, had for its object the investigation of the laws, customs, and beliefs of the native tribes under British rule in Central Africa, particularly in the Uganda Protectorate, in accordance with a scheme which had been planned and urgently advocated for many years by Sir James Frazer, but for which funds had hitherto been wanting. The tribes which the expedition proposed to investigate had been very little modified by contact with civilisation, and it was felt that a detailed examination of their institutions and beliefs would not only add very materially to our scientific knowledge, but would also conduce to the good government and economic development of the country in the future.

The expedition left this country in the spring of 1919. The first part of its labours was devoted to the study of the Bahima of Ankole, an important pastoral tribe, in the western part of the Uganda Protectorate. During a stay of three months Mr. Roscoe gathered an immense amount of detailed information relating to the clan and totem organisation and tabus, the system of government, and the beliefs and rituals connected with the care of cattle and the milk, which play an important part in regulating the life of the community.

From Ankole the expedition moved to Kigezi, where a short stay was made for the purpose of studying the Bakyiga, a large and fierce mountain tribe of many clans, partly pastoral, partly agricultural. The tribe is believed to be the original stock, which the Bahima were never able to conquer. This is borne out by the fact that they are of the same type as the slaves in Ankole and the lower order of people in Bunyoro.

On leaving Kigezi the expedition set out for Bunyoro, proceeding westward to the arm connecting the two lakes Edward and George, and then northward along the line of these lakes and Lake Albert—a country very little known, which was found to be of extraordinary beauty.

In the course of a short rest of a week a superficial examination of the Bamba and Bakonja of Mount Luenzori was made. The expedition then proceeded from Port Ntoroko by steamer to Butiaba, the port for Masindi, the capital of Bunyoro, where it entered upon the second and, as it proved, the most fruitful part of its labours.

The King of Bunyoro gave every assistance to the expedition. He is now a Christian, but as the repository of the tradition and practice of the religion of the people his knowledge, which was placed freely at Mr. Roscoe's disposal, proved of inestimable value.

The Bunyoro tribe, or rather nation, consists of two distinct races, the Bahuma and the Bairu—the latter a subject people of agricultural peasants belonging to Bantu stock and descended from the original inhabitants of the country; the former a purely pastoral people akin to the Gallas, who form a ruling aristocracy, descended from a people which invaded and conquered the country from the north. Intermarriage between the two races is rare, though not absolutely forbidden. The greater part of the life of the king is, or rather used to be, devoted to ceremonial observances connected with his cattle in order to increase the progeny of man and beast and the supply of food. So much was this the case that the whole of his day was mapped out for him, and he rarely, if ever, quitted his kraal. One peculiar feature of the ritual was a daily meal at which he partook of sacred beef. The royal cook knelt before the king and placed four pieces of meat in the king's mouth with a special fork, taking care not to let the fork touch the royal teeth under penalty of death.

From Masindi the expedition proceeded to Mount Elgon, where it made some further inquiries among the cannibal Bagesu, whom Mr. Roscoe had already visited and described. It had been intended originally to pass northward into Karamojo in order to investigate the Turkana, an interesting people, remarkable for their great stature, of whom very little in detail is known. Unfortunately, military operations which were being carried on in that region made that impossible. The expedition therefore turned to Busoga, and after a short stay there returned to Bunyoro, whence it started on its homeward journey down the Nile.

E. N. F.

The Indian School of Mining and Geology.

THE recent decision of the Government of India to establish a School of Mining and Geology at Dhanbaid follows the recommendations of Sir Duncan McPherson's Committee of 1913–14 on mining education, of the expert Committee which examined the system of mining education in England in 1914–15, and of the Indian Industrial Commission of 1916–18. The site of the proposed school has caused some difference of opinion in the past. Thus the Calcutta University Commission enumerated the many advantages which Calcutta was believed to possess, but in finally deciding on Dhanbaid the Government of India has followed the recommendations of the three Committees, and come to a conclusion with which those who know local conditions best will cordially agree. Dhanbaid enjoys an excellent situation, and return visits to the coal-mines will occupy only a few hours; from Calcutta they would take at least thirty-six hours.

The provision at present made for mining education in India comprises (1) courses at the Sibpur Engineering College, near Calcutta, and (2) evening classes on the coalfield. The existing provision for higher training in geology is even less satisfactory. The proposal is that the new school will be an institution of collegiate type, in which the highest form of teaching in the art of mining and its accessory sciences is to be undertaken, so that in time it will rank with similar institutions in this country, and give equal opportunities for the study of geology and mining in all their branches. Thus natives of India will eventually be able to obtain in their own country that specialised training which to-day is an essential qualification for the more responsible posts in the mining and geological professions.

With the school on the coalfield both students and staff will be in close contact with a well-developed mining industry, and the great desirability of having intimate relationship between the industry and mining education will be realised. Further, the teachers of the evening classes, who undertake part of the work of imparting elementary mining education at present, will be enabled to keep themselves *au courant* with the latest developments and to obtain advice and assistance from the school.

The Central Government will assume responsibility for its maintenance and administration, as the development of India's mineral industry is an Imperial undertaking which affects vitally the general advancement of the country as a whole. Under the Reforms Scheme only central agencies and institutions for research and for professional or technical training or for the promotion of special studies will be under the Government of India, as it is only for such that funds can be allotted from the Imperial revenues.

The fact that both coal and metalliferous mines are now being developed in other Provinces is not lost sight of. The school will be open to students from all parts of British India, and facilities are to be provided for others from the Indian States. Although the school will supply trained officials for the coal-mining industry, it has been definitely laid down that instruction in metalliferous mining shall receive due attention. It is hoped that provincial Governments, mining associations, and the great mining companies of India will give liberal support to the school by the institution of scholarships, travelling fellowships, and lectureships.

Elementary instruction in coal and metalliferous mining is not one of the objects of the school; this will receive due care from the provincial Governments concerned. A final decision has not yet been reached with regard to the higher training of mine surveyors, which is left for the future consideration of the governing body. Should a metallurgical institute be established in the future at Jamshedpur, full arrangements are to be made for the interchange of facilities in research and advanced training between it and the new School of Mines and Geology.

The school will not be affiliated to any university, at least in its initial stages, though it must, of course, maintain touch with the highest form of educational thought, methods, and standards. Both the Universities of Calcutta and Patna will be represented on the governing body. The latter consists of fourteen members, presided over by the Director of the Geological Survey of India. Other official members are the Chief Inspector of Mines, the principal of the college, and the representatives of the Governments of Bengal and of Bihar and Orissa. The rest are non-officials, appointed by the mining associations, etc., of various parts of India, and the two university members already mentioned.

Steps have already been taken to acquire a suitable site at Dhanbaid, and the governing body is to formulate proposals at once for buildings and equipment, staff, courses of study and examinations, rules of admission and an estimate of the initial and recurring costs of the school.

J. C. B.

University and Educational Intelligence.

CAMBRIDGE.—Mr. A. B. Appleton (Downing College), Mr. D. G. Reid (Trinity College), and Mr. A. Hopkinson (Emmanuel College) have been appointed demonstrators in anatomy, and Mr. A. Hutchinson (Pembroke College) has been re-appointed demonstrator in mineralogy and assistant curator of the museum of mineralogy. It is proposed that Dr. Myers should be appointed reader in experimental psychology, and that the University lectureship which he now holds should cease.

A LECTURE on "Recent Developments in Astronomy," in connection with the London County Council's lectures for teachers, will be given by Prof. A. Fowler at the Regent Street Polytechnic, W.1, on Saturday morning, December 4, at 10.30 o'clock. The chair will be taken by Mr. E. Walter Maunder.

THE Toronto correspondent of the *Times* stated on November 25 that, including the grant of 1,000,000 dollars from the Government of the Province of Quebec and 1,000,000 dollars from the Rockefeller Foundation, the McGill University centennial endowment fund has reached the total of 6,321,000 dollars (approximately 1,580,000*l*.), which exceeds the amount the recent campaign was started to raise.

AN exchange of university students between Belgium and the United States has recently been made; twenty-four Belgian students have been admitted to American universities and twenty-two Americans have entered Belgian universities. The exchange has been arranged and endowed by the Education Foundation of the Belgian Relief Commission from funds which remained after the Commission had completed its work in 1919. All travelling expenses of the selected students will be met from this fund, and fees will be remitted by the Belgian and some of the American universities for exchange students. In addition, Belgians entering American universities will each receive a maintenance grant of 1000 dollars per annum, while American students in Belgian universities will each be allowed a sum of 10,000 francs per annum for living expenses.

IN his presidential address to the members of the British Academy, now reprinted, Sir F. E. Kenyon discussed the subject of international scholarship. Like other societies, the Academy suffers from lack of funds, and the appeal now made for a Treasury grant will meet with the support of all who are interested in learning. The question of the resumption of relations with German scholars was considered, and while Sir F. Kenyon sees the difficulties which impede any *rapprochement*, he "looks forward to the revival of normal relations between English and German scholars, and I desire that it may come without delay." Meanwhile, international organisation of scholarship need not be suspended, and we can work in full accord with our Allies. As a result of a meeting held in Paris in 1919 a series of proposals for future work was submitted by the representatives of the nations present. Sir F. Kenyon's review of these proposals deserves careful consideration.

THE calendar of the West of Scotland Agricultural College for the session 1920–21 has just been received. The college undertakes to give instruction in general agriculture, dairying, forestry, horticulture, and poultry keeping to farmers, teachers, and grocers as well as to students studying for the regular diplomas, certificates, and degrees. The course provided for farmers is held during the winter months and completed in one session; it is intended for the sons of farmers who are unable to take full-time courses. At the grocers' class, held in conjunction with the Glasgow Grocers' and Provision Merchants' Association, the lectures deal principally with milk, butter and butter-making, cheese and cheese-making, bacon, and eggs. For full-time students courses are provided which lead to college certificates and diplomas in agriculture, dairying, forestry, and horticulture and to the various national diplomas which are granted, while lectures in preparation for the degree of B.Sc. (Glasgow) are also given. The year is divided into two terms, a winter session which is held in Glasgow, and a summer session spent at the experimental schools at Kilmarnock. Evening lectures are available, and a certain amount of extension work in the form of lecturing at local institutes, conducting experiments, giving expert advice to farmers, etc., is also done.

A LARGE and impurtant part of the extension work of most of the universities, colleges, and departments of education in the United States of America is done by correspondence methods (Bureau of Education, Bulletin No. 10, 1920). A list of the institutions developing this means of satisfying the desire for knowledge contains no fewer than thirty-eight universities. Seventy-three institutions are given in all, of which sixty-one are supported by public funds, and they are conducting correspondence courses for nearly one hundred thousand students. The Massachusetts Board of Education has provided some figures which show the motives actuating the pupils who enrolled for their correspondence courses, and also their previous educational history. More than 50 per cent. undertook courses in the hooe of immediate practical gain, while only 22 per cent. began the work from motives of culture or enjoyment; the educational history of the pupils showed that 49 per cent. came from secondary schools, and 35 per cent. had received elementary education only. At the same institution 76 per cent. of those who enrolled for correspondence classes were above school-age; the average age was 26·3 years. The results obtained from studies of the ages of correspondence students in the University of Wisconsin, Indiana University, and other institutions differ little from those obtained in Massachusetts.

THE University Colleges of Newcastle-upon-Tyne—the College of Medicine and Armstrong College, both of which are units of the University of Durham—have launched an appeal to the district they serve for 500,000*l.* A large committee representing the four northern counties has been set up, under the presidency of Viscount Grey of Fallodon, and at a recent meeting, at which the Duke of Northumberland acted as chairman, this committee pledged itself to do all in its power to relieve the colleges from their present embarrassment. The financial position of Armstrong College is little short of desperate. In July, 1921, the college will be faced with an annual recurring deficit of more than 19,000*l.*; the salaries of the staff, though they have already been augmented, are still far too low; it has been found impossible to keep equipment up to date; and students have had to be refused admittance in large numbers. This college, the only university college between Leeds and Edinburgh which teaches science, is faced with bankruptcy. The situation of the College of Medicine, though less serious financially, is also unsatisfactory. It is badly hampered by lack of accommodation, and unable to develop its teaching to the full along modern lines. Believing that their needs have only to be made widely known to their district to be relieved, the two colleges have thrown themselves upon the generosity of Tyneside and the surrounding counties.

A PUBLIC meeting was held on Thursday, November 25, at the Leeds Town Hall, under the presidency of the Lord Mayor, to inaugurate an appeal for funds for the University of Leeds. The University is asking the public of Yorkshire, and others interested in the progress of higher education in the county, for 500,000*l.*, and the Vice-Chancellor (Sir Michael Sadler) was able to announce to the meeting that towards this fund gifts amounting to 112,800*l.* had already been received or promised. Amongst those who spoke in support of the appeal were representatives of local authorities, who contribute largely to the revenue of the University, and a number of prominent professional and business men. The needs of the University for additional funds were explained at the beginning of the meeting by the chairman of the council (Mr. Arthur G. Lupton), the treasurer (the Hon. Rupert Beckett), the Vice-Chancellor, and Prof. Smithells. The number of students in the University is now nearly three times as large as before the war. Most of the departments are overcrowded, and the annual expenditure of the University has enormously increased as a necessary consequence of the new conditions created by the war. New laboratories are required in nearly all the University's departments of pure and applied science and for the school of medicine, and new buildings are needed for the department of agriculture, the school of dentistry, the University library, the Students' Union and gymnasium, and as halls of residence for men and for women students. A large addition to the general endowment fund of the University is also desired.

Societies and Academies.

LONDON.

Royal Society, November 18.—Sir J. J. Thomson, president, in the chair.—Sir A. **Schuster**: The absorption and scattering of light. The paper is based on the generally accepted theory that refraction and dispersion are caused by the oscillations of electric resonators embedded in the medium through which the light passes. With homogeneous light each resonator responds with a forced oscillation, together with a motion following the laws of free oscillations, and gradually dying out. If white light falls on the medium the forced oscillation has to be replaced by an integral and other terms have to be added that are due to disturbances caused by neighbouring molecules. The equation for the displacement of an oscillator then takes the form:

$$z=\int_0^\infty \mathrm{E}f(n,w)\cos(wt-\epsilon)\,dw+\Sigma \mathrm{C}_s e^{-\kappa(t-t_s)}\sin\sqrt{n^2-\kappa^2}(t-t_s).$$

The principal result of the paper is that all the terms of this equation are spectroscopically identical. If the proper value for $f(n, w)$ be introduced, and if E be regarded as constant, then the integral in the first term of the right-hand side is merely the analytical representation by Fourier's integral of any of the terms of the summation, with a proper adjustment of ϵ and t_s. As it stands, it represents a motion beginning at time $t=0$ and continuing according to the laws of a damped oscillator. The mechanism of scattering and absorption is discussed, and Lord Rayleigh's equation for the coefficient of extinction in a scattering medium is obtained in a more vigorous manner, so as to include cases where $\mu-1$ is not necessarily small.—Prof. O. W. **Richardson**: The emission of electrons under the influence of chemical action. The electron currents to a surrounding metal electrode from spherical drops of the liquid alloy of sodium and potassium under the influence of chemical action with a number of gases have been investigated and measured under various conditions. The gas which has been studied most is phosgene ($COCl_2$), then, in decreasing order, Cl_2, H_2O, and HCl. In all cases the relation between the current and the applied potential difference is of the same general character. When proper allowance is made for the contact potential difference between the two metal surfaces it is found that the electron currents are nearly constant for small accelerating electric fields. Thus, as in the case of photo-electric emission, the saturation value of the current is reached with a potential difference very close to zero. With retarding fields the currents fall off rapidly as the applied potential difference increases. Like similar thermionic electron currents, they approach the voltage axis gradually and not sharply, as in the photo-electric case. The true zero on the voltage scale is difficult to determine on account of fluctuations in the contact potential difference. In the case of $COCl_2$ it has been possible to locate the zero to within 0·10 volt by a photo-electric method. The proportion of the chemically emitted electrons the kinetic energy of which lies between u and $u+du$ is very closely represented by

$$\frac{udu}{k^2T^2}e^{-u/kT}$$

where k is Boltzmann's constant and T is a certain temperature. For the case of $COCl_2$, T is near 3300° K, and for the case of Cl_2, T is about 4900° K. The formula above represents a Maxwell distribution for the temperature T. Thus the distribution of kinetic energy among the chemically emitted electrons is the same as that among the molecules of a gas at the uniform temperature T.—Dr. A. E. **Oxley**: Magnetism and atomic structure. This communication is an extension of former papers on "The Influence of Molecular Constitution and Temperature on Magnetic Susceptibility" (Phil. Trans. Roy. Soc., vol. ccxiv., A, 1914; vol. ccxv., A, 1915; and vol. ccxx., A, 1920). From Tyndall's work and recent experiments of the author on the characteristic deportment of diamagnetic and paramagnetic crystals in the magnetic field, it appears that in non-ionised crystal structures the fundamental unit of the space lattice is the molecule. It is shown that the electron orbits in atoms must be distributed in space round the nucleus, each electron describing a small orbit, or alternatively the electron itself may be a complex unit endowed with magnetic properties. In either case the distribution must be such that the aggregate projected area of the electron orbits on a plane perpendicular to the principal cleavage is a maximum in both diamagnetic and paramagnetic crystals. This result is consistent with a closer packing of the molecules in a direction parallel to the principal cleavage. In crystals of the simple cubic form X-ray analysis has indicated that the structure is an ionised-atomic one, and the cleavages are all of equal value. Such crystals show no appreciable structural deportment in the magnetic field. The above views relating to electron distribution are consistent with the cubical atom theory of Lewis and Langmuir, but not with Bohr's theory. The coupling forces between atoms and molecules in non-ionised crystals are due to the mutual magnetic induction between pairs of electron orbits. A model of the hydrogen molecule is given, in which the arrangement of the coupling units determines a diamagnetic molecule as required by experiment. It is considered that the above views and those of Bohr may eventually be brought into line by a fuller recognition of the possible differences between radiating and non-radiating matter.—Prof. A. O. **Rankine**: The proximity of atoms in gaseous molecules. In this investigation a close examination is made of the relations between the estimates of atomic diameters obtained by Prof. W. L. Bragg from X-ray crystal measurements and those deduced from the kinetic theory of gases. The examination is carried out from the point of view of the Lewis-Langmuir molecular theory. It is shown that if, for example, a hypothetical molecule be constructed of two argon atoms with their centres separated by the distance demanded by Prof. W. L. Bragg's figures, the behaviour of such molecules in thermal agitation would be almost identical with the actual behaviour of chlorine molecules. Similar relations are shown to exist for the pairs of gases neon-oxygen, krypton-bromine, and xenon-iodine. The following conclusions are regarded as justified: (*a*) There is substantial *quantitative* agreement between the estimates of atomic dimensions deduced from X-ray crystal measurements and from the kinetic theory of gases. (*b*) In size and shape the atoms of the monatomic inert elements are nearly indistinguishable from the atoms respectively of the neighbouring diatomic elements in the periodic table. (*c*) The Lewis-Langmuir molecular theory accounts satisfactorily for the kinetic behaviour of the molecules of oxygen, chlorine, bromine, and iodine in relation to the behaviour of the corresponding inert atoms neon, argon, krypton, and xenon.—Prof. A. O. **Rankine**: The similarity between carbon dioxide and nitrous oxide. The two gases in question have been shown by Langmuir to have almost identical physical properties. In particular, they have the same viscosity, and the application of modern kinetic theory indicates that their molecules have the same size and shape. In the present paper it is shown, by the extension of methods already described by the author, that the kinetic behaviour of the molecules of both CO_2 and N_2O is consistent with their being identical in size and shape with three neon atoms in line and contiguous, *i.e.* with outer electron shells touching. This is in accordance with Langmuir's view of the constitution of these molecules.—Dr. A. M. **Williams**: Forces in surface films. I.: Theoretical considerations. II.: Experimental observations and calculations. III.: The charge on colloids. I. and II.: Attention is directed to the effects of (i) accessibility of surface and (ii) adsorption on the apparent specific volume of finely divided solids. A simple theory of these effects is developed, with which observations are in agreement. The true specific volume of a specimen of charcoal, which appeared to be 0·51 in water and 0·46 in chloroform, was evaluated as 0·67 c.c. per gm. The attractive pressure on the surface film on the charcoal was calculated and found to be of the order of 10,000 atmospheres, while the internal pressure of the charcoal itself was evaluated as of the order of 50,000 atmospheres. III.: It is shown that compressive forces of the order previously determined may give rise in the adsorption layer to a diffusion potential difference of the magnitude observed in the case of suspensoids. The influence of the diffusion of hydrogen- and hydroxyl-ions on the potential difference is emphasised, and the neutralisation of the charge on suspensoids and their consequent precipitation explained in terms of diffusion potential.

Physical Society, November 12.—Sir W. H. Bragg, president, in the chair.—Dr. F. H. **Goucher**: Ionisation and excitation of radiation by electron impact in helium. Measurements have been made of the critical potentials for helium by the method used in the experiments of Davis and Goucher, these being compared with the ionising potential of mercury vapour taken as a standard. Assuming the ionising potential of mercury to be 10·4 volts, two critical potentials occur in helium, one at about 20 volts and the other at about 26 volts. These critical values agree well with those obtained by Horton and Davies. The effect of radiation alone on the metal parts of the apparatus was studied under conditions which would yield evidence of use in the interpretation of the results obtained when the production of both ionisation and radiation was taking place simultaneously. The conclusion was drawn that the lower critical potential was a radiation potential, though some ionisation was produced also at this potential. This, however, was attributed to the presence of impurity, probably hydrogen. The higher critical potential was that at which ionisation took place.—J. **Guild**: The location of interference fringes. The conditions under which interference fringes, produced by reflection of light from the two surfaces of a "thick plate," are visible to an observer. The treatment lays stress on the physical significance of the term "location" as applied to interference fringes and on the dependence of the observed phenomena on the conditions of observation. For a broad source of light a formula is obtained which is equivalent to that derived by Michelson. For a joint source of light at infinity it is shown that the fringes obtainable are equally visible at all distances from the plate.—J. **Guild**: Fringe systems in uncompensated interferometers. An investigation of the form of the fringe system observable at infinity, or in the focal plane of a telescope, when a broad source is employed with a Michelson interferometer in which the glass paths of the two interfering beams are not equal. The fringes may be elliptical or hyperbolic, with circles and straight lines as special cases. In the recently developed method of using the instrument for optical testing, the fringes due to a joint source at infinity are employed. It is shown that the form of the fringes in this case are unaffected by lack of compensation, but that the visibility of the fringes is conditioned by the nature of the fringe system due to a broad source.—Dr. G. **Barr**: A new relay for heavy currents. The action of the relay depends on the fact that no arc can be maintained between mercury electrodes in hydrogen. One lead is brought to mercury contained in a vertical tube within a solenoid. An iron rod, at the upper end of which is a glass cup floats in the mercury. The cup also contains mercury, and the other lead is connected to an iron rod which dips into this. When no current flows in the solenoid the rim of the cup is about 1 cm. above the level of the main body of mercury. When the relay current (about 0·03 ampere) is running the iron rod is sucked down until the rim of the cup is submerged by about 0·5 cm. The space above the mercury contains hydrogen. The relay can be used to break quite large currents (20 amperes) without much spark.

EDINBURGH.

Royal Society, November 1.—Prof. F. O. Bower, president, in the chair.—Three connected papers by Dr. J. **Rennie**, Miss Elsie **Harvey**, and B. **White**: The Isle of Wight bee disease. The results of these investigations, which were being carried out in the Parasitical Laboratory at Aberdeen, showed that the so-called Isle of Wight disease was due to a small mite living in the respiratory system of the bee. This was contrary to the views advanced some eight years ago by workers in England, who claimed that the causal organism was a protozoon named *Nosema apis*. Mr. Anderson, of Aberdeen, was the first to call in question this hypothesis, and the series of papers now presented established the existence of a new type of parasitism in bees of a remarkable kind. The small mite which was the cause of the disease belonged to the genus Tarsenemus. It was highly specialised in structure, was bred within the bee, and was confined to an extremely limited, but very important, region of its breathing system. Within the space of a few cubic millimetres scores of these creatures might be seen in all stages of development, sometimes packed in dense columns so as to cut off effectually the air-supply from the surrounding organs. The detailed pathology described in Mr. White's paper proved the destructive character of the parasites' habits. Thousands of bees had been examined from large numbers of stocks throughout the country, and it had been found that every stock reported by trustworthy beekepers or certified by the investigators as suffering from the disease harboured this parasite. Similarly, every individual bee known from its stock-history and individual symptoms to be suffering from the disease was likewise found to contain these parasites and to exhibit the internal disorders which caused the disabling symptoms. The investigators stated that they were now able to diagnose the disease in its earliest stages while the bees were capable of flying and foraging. Miss Harvey's researches showed that infection appeared to occur mainly in the hive, the conditions of the cluster making this comparatively easy. Mites had been obtained from the outside of the bee apparently on their migratory passage. Tarsenemus included several species destructive to plants, and there were some which have been found in malignant growths in man and other animals. The bee parasite was more closely allied to the latter group. Many bees from different countries outside Great Britain have been examined, and so far Tarsenemus has not been found in these. All the evidence hitherto obtained points to the parasite being peculiar to this country, coinciding with the general testimony regarding the insular character of the Isle of Wight disease. This name had long been regarded as unsatisfactory, and "acarine disease" was proposed as more appropriate. In view of the great practical interest taken by Mr. A. H. E. Wood, of Glassel, in the work of the research. Dr. Rennie proposed to designate the new species *Tarsenemus Woodi*. To Mr. Wood and to the Development Commissioners special recognition was due for having provided in equal measure funds necessary to finance the investigation, and the authors also record their high appreciation of the support of beekeepers throughout the country in supplying bees and other assistance so essential for the successful conduct of the research.—Prof. J. H. M. **Wedderburn**: The equations of motion of a single particle.

PARIS.

Academy of Sciences, November 8.—M. Henri Deslandres in the chair.—L. **Lecornu**: The permanent movements of liquids.—P. **Termier** and W. **Kilian**: The western edge of the glittering schists in the Franco-Italian Alps between Haute-Maurienne and Haut-Queyras. A discussion of the question as to whether the contact between these schists and the Briançon series is normal or abnormal. A careful study of more than 100 km. shows that the contact of these two strata has none of the characters of a normal contact, and the idea of a stratigraphical continuity is highly improbable.—L. **Lumière**: The photographic representation of a solid in space. Photostereo-synthesis.—H. **Parenty** and G. **Vandamme**: Utilisation of the energy of tides and waves. A description of an arrangement of cells made of reinforced concrete, by means of which air is compressed or rarefied by the shock of the waves. The apparatus has been constructed and gives pressures of 2–3 kg.—J. **de Lassus**: A transmission of mechanical energy utilising an invariable mass of gas in closed circuit.—A. **Danjon**: A new variable star of short period. The star *d* Cygnus varies in magnitude from 5·16 to 5·36, and the passage from maximum to minimum may be observed during one evening.—L. **Dunoyer**: Remarks on an article by Irving Langmuir and on another by R. W. Wood. A question of priority.—E. **Jouguet**: Application of the Carnot-Clausius principle to waves of shock in elastic bodies.—R. **Biquard**: Abnormal indications furnished by radiochromometers with very penetrating X-rays. The principle upon which Benoît's radio-chromometer depends is not valid for the X-rays from a Coolidge tube under a potential of 60,000 volts or higher, and the use of this instrument should be confined to the measurement of X-rays of medium or low penetration such as those utilised in medical radiography or superficial radio-therapy.—L. and E. **Bloch**: The spark spectra of mercury, copper, zinc, and thallium in the extreme ultra-violet. The measurements were made with a prism spectrograph, and the wave-lengths given are based on Lyman's data obtained with a grating. New lines are given for all four metals.—C. **Raveau**: The determination of the number of independent components. The rule of M. Dubreuil; the action of water on a mixture of salts.—J. B. **Senderens**: The catalytic dehydration of fermentation amyl alcohol. Catalysis by aluminium silicate at 340° to 350° C. gives a mixture of three amylenes, and the proportion in which these are present depends on the length of time the catalyst has been in use. The first litre of amylenes collected contained 93 per cent. of amylene soluble in diluted sulphuric acid, the third litre only 75 per cent.—R. **Cornubert**: The spectrochemical study of the α-allyl- and α-allylmethyl-*cyclo*hexanones.—L. **Duparc** and G. **Favre**: The deposit of oolitic iron ore at Ain-Babouche (Algeria).—H. **Jumelle**: The katoka, a Madagascan tree with edible seeds. The tree is a new species of the genus Treculia, and is named *Treculia Perrieri*. It is abundant in the west of Madagascar and produces a good wood and edible seeds. The latter are consumed by the natives as food, and have been imported into France for the extraction of their oil.—H. **Bouygues**: The terminal meristem of the stem and its division into regions.—P. **Lesage**: Evaporometers and the motion of fluids through membranes.—A. **Damiens**: The bromine and chlorine existing normally in animal tissues. Bromine was found in all the organs examined, except in two or three cases where the quantities of material available were too small. The ratio of bromine to chlorine in the organs of any given animal is sensibly constant, and is of the order 0·001 to 0·002.—L. **Mercier**: Variation in the number of the fibres of the longitudinal vibrator muscles in *Chersodromia hirta*. Loss of the power of flight.—C. **Julin** and A. **Robert**: Organogenesis in the blastozoites of Perophora.—T. **Tommasina**: Remarks on the note by M. Louis Besson on the relation between the meteorological elements and the number of deaths by inflammatory diseases of the respiratory organs at Paris.

Books Received.

The Birds of the British Isles and their Eggs. By T. A. Coward. Second Series: Comprising Families Anatidæ to Tetraonidæ. Pp. vii+376+159 plates. (London and New York: F. Warne and Co., Ltd.) 12s. 6d. net.

Considérations sur l'Etre Vivant. By C. Janet. Première Partie. Pp. 80+1 planche. (Beauvais: A. Dumontier.)

The Annual of the British School at Athens. No. xxiii., Session 1918–19. Pp. xvi+260+xvi plates. (London: Macmillan and Co., Ltd.) 30s. net.

Anxiety Hysteria: Modern Views on some Neuroses. By Dr. C. H. L. Rixon and D. Matthew. Pp. xi+124. (London: H. K. Lewis and Co., Ltd.) 4s. 6d. net.

From the Unconscious to the Conscious. By G. Geley. Translated by Stanley de Brath. Pp. xxviii+328. (London: W. Collins, Sons and Co., Ltd.) 17s. 6d. net.

Functional Mental Illnesses and the Interdependence of the Sympathetic and Central Nervous Systems in Relation to the Psychoneuroses. By Dr. R. G. Rows and Dr. D. Orr. Pp. 63. (Edinburgh and London: Oliver and Boyd.) 3s. 6d.

Äther und Relativitäts-Theorie. Rede gehalten am 5 Mai 1920 an der Reichs-Universitäts zu Leiden. By A. Einstein. Pp. 15. (Berlin: J. Springer.) 2.80 marks.

The Progress to Geography. By Dr. R. Wilson. Stage 1: Pictures and Conversations. Pp. 144. 2s. 6d. Stage 2: More Pictures and Conversations. Pp. 176. 3s. (London: Macmillan and Co., Ltd.)

Ministry of Health. Annual Report of the Chief Medical Officer, 1919–20. (Cmd. 978.) Pp. 393. (London: H.M. Stationery Office.) 3s. 6d. net.

Memoirs of the Geological Survey. Special Reports on the Mineral Resources of Great Britain. Vol. vii.: Mineral Oil, Kimmeridge Oil-Shale, Lignites, Jets, Cannel Coals, Natural Gas. By Sir A. Strahan. Second edition. Pp. iv+125. (London: E. Stanford, Ltd.: Southampton: Ordnance Survey Office.) 5s. net.

Productive Soils. The Fundamentals of Successful Soil Management and Profitable Crop Production. By W. W. Weir. Pp. xvi+398. (Philadelphia and London: J. B. Lippincott Co.) 10s. 6d. net.

An Introduction to the Structure and Reproduction of Plants. By Prof. F. E. Fritch and Dr. E. J. Salisbury. Pp. viii+458. (London: G. Bell and Sons, Ltd.) 15s. net.

British Plants: Their Biology and Ecology. By J. F. Beirs and H. J. Jeffery. Second edition. Pp. xii+346. (London: Methuen and Co., Ltd.) 7s. 6d.

Public Health Chemical Analysis. By R. C. Frederick and Dr. A. Forster. Pp. viii+305. (London: Constable and Co., Ltd.) 21s. net.

Hydraulics with Working Tables. By E. S. Bellasis. Third edition. Pp. viii+348. (London: Chapman and Hall, Ltd.) 18s. net.

Practical Physiological Chemistry. By S. W. Cole. Sixth edition. Pp. xvi+405. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin, Marshall and Co., Ltd.) 16s.

Collected Papers on the Psychology of Phantasy. By Dr. C. E. Long. Pp. xii+216. (London: Baillière, Tindall and Cox.) 10s. 6d. net.

The Origin of Man and of his Superstitions. By C. Read. Pp. xii+350. (Cambridge: at the University Press.) 18s. net.

Maryland Geological Survey. Cambrian and Ordovician. Pp. 424+lviii plates. (Baltimore: Johns Hopkins Press.)

Report on the Danish Oceanographical Expeditions, 1908–1910, to the Mediterranean and Adjacent Seas. By Dr. Johs. Schmidt. No. 6. Vol. ii.: Biology. Pp. 140+110. (Copenhagen: A. F. Høst and Son.)

La Chimie et la Guerre. Science et Avenir. By Prof. C. Moureu. Pp. iii+384. (Paris: Masson et Cie.) 10 francs.

Diary of Societies.

THURSDAY, DECEMBER 2.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.—Major G. H. Scott: Airship Piloting.—Flight-Lieutenant F. L. C. Butcher: Airship Mooring.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. W. Brown: The Value of Suggestion in Education.

CHEMICAL SOCIETY, at 8.—Sir Prafulla C. Rây: Varying Valency of Platinum with Respect to Mercaptanic Radicles.—H. E. Cox: The Influence of the Solvent on the Velocity of certain Reactions. Part II. Temperature Coefficients. A Test of the Radiation Hypothesis.—K. J. P. Orton and P. V. McKie: Preparation of Chloropicrin from Picric Acid and Trinitrotoluenes.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—C. White: Sodium Bicarbonate Tolerance in the Toxæmias of Pregnancy.—Major C. A. F. Hingston: The Necessity for the Reduction of Blood Pressure in Eclampsia.—Dr. R. W. Johnstone and Dr. J. Young: Case of Accidental Hæmorrhage associated with Eclampsia.—Dr. J. Young and Dr. D. Miller: Further Observations on the Etiology of Eclampsia and the Pre-eclamptic State.

FRIDAY, DECEMBER 3.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 4.45.
ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—The Cause of Magnetic Storms.—In Chair: J. H. Jeans. Opener: Prof. F. A. Lindemann.—Other Speakers: Prof. S. Chapman, Dr. C. Chree, Rev. A. L. Cortie, Major G. M. Dobson, E. W. Maunder, C. S. Wright, and Others.
INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Further Discussion on The Human Factor in Industry, by A. Ramsay.
INSTITUTION OF ELECTRICAL ENGINEERS (Students' Section) (at King's College), at 6.30.—A. Serner and Others: Discussion on The Modern Tendency to Trusts. Is it Beneficial?
JUNIOR INSTITUTION OF ENGINEERS (at Caxton Hall), at 8.—G. F. Shotter: Electrolysis as applied to the Measurement of Water.
ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Informal Meeting.

SATURDAY, DECEMBER 4.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—H. J. Elwes: The Primitive Races of Sheep in Great Britain.

MONDAY, DECEMBER 6.

VICTORIA INSTITUTE, at 4.30.—Dr. D. Anderson-Berry: The Psychology of Man, Experimentally Considered.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Berkeley Moynihan: The Surgery of the Diseases of the Spleen (Bradshaw Lecture).
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.
SOCIETY OF ENGINEERS (Inc.) (at Geological Society), at 5.30.—H. Banks: Blackpool Sea Coast Defence Works.
ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street), at 8.—Prof. W. P. Montague: Variation, Heredity, and Consciousness.
SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—Dr. H. Levinstein: The Dyestuff Industry.
ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Major-Gen. L. C. Dunsterville: From Baghdad to the Caspian in 1918.
MEDICAL SOCIETY OF LONDON (at 11 Chandos Street, W.1), at 8.30.—The Surgical Treatment of Malignant Disease of the Colon, introduced by Sir Berkeley Moynihan, to be followed by Sir W. Arbuthnot Lane, Bt., G. Wright, L. Mummery, G. G. Turner, and H. W. Carson.

TUESDAY, DECEMBER 7.

ROYAL SOCIETY OF ARTS, at 4.30.—A. H. Ashbolt: The Trade of Australia During and After the War.
INSTITUTE OF INDUSTRIAL ADMINISTRATION (at Central Hall, Westminster), at 7.—R. Twelvetrees: Road Transport as an Aid to Industrial Management.
ROYAL SOCIETY OF MEDICINE (Surgery: Sub-section of Orthopædics), at 5.30.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—F. Martin-Duncan: Photomicrography from the Ordinary Photographer's Point of View: Exhibition of Various Forms of Photomicrographic Apparatus and Demonstration of Use.
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—L. S. Palmer: Some Late Keltic Remains from a Mendip Cave.
SOCIOLOGICAL SOCIETY (at 65 Belgrave Road), at 8.15.—Major Douglas: The Mechanism of Consumer-Control.
ROYAL SOCIETY OF MEDICINE (Pathology Section) (at Laboratories of Medical Research Council, Mount Vernon, Hampstead), at 8.30.—Prof. L. Hill: The Measurement of the Capillary Blood Pressure.—Capt. S. R. Douglas: The Serological Races of the Cholera Vibrio.—Dr. W. Mair: Dohler's Bodies in Scarlet Fever and Pneumonia.—J. E. Barnard: The Use of Ultra-Violet Light in the Differentiation of Animal Tissues.—Dr. L. Colebrook: Actinomyces.—Major H. W. Acton: The Formation of the Gametocyte of Benign Tertian Malaria.—Dr. Lovatt Evans: A Method for the Determination of the Reaction of Blood.

WEDNESDAY, DECEMBER 8.

ROYAL SOCIETY OF ARTS, at 4.30.—E. A. Brayley Hodgetts: A Retrospect of the Personal Influence of Britons in Russia.
INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.

THURSDAY, DECEMBER 9.

ROYAL SOCIETY, at 4.30.—*Probable Papers*.—Lord Rayleigh: Doubly Refracting Structure of Silica Glass.—Prof. J. W. Nicholson and Prof. T. R. Merton: The Effect of Asymmetry on Wave-Length Determinations.—Prof. T. R. Merton: The Effect of Concentration on the Spectra of Luminous Gases.—Prof. E. Wilson: The Measurement of Low Magnetic Susceptibility by an Instrument of New Type.—Prof. W. T. David: The Internal Energy of Inflammable Mixtures of Coal-Gas and Air after Explosion.—Prof. A. McAulay: Multenions and Differential Invariants.
LINNEAN SOCIETY, at 5.—Prof. R. Newstead: Uganda Biology (Lantern Lecture).
LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—S. Beatty: The Algebraic Theory of Algebraic Functions of One Variable.—F. Debono: The Construction of Magic Squares.—Prof. A. S. Eddington: An Application of the Calculus of Tensors to the Theory of Finite Differences.—Prof. A. R. Forsyth: Developable Surfaces through Two Curves in Different Planes.—J. E. Jones: The Distribution of Energy in the Neighbourhood of a Vibrating Sphere.—L. J. Mordell: (1) The Reciprocity Formula for the Gauss's Sums in a Quadratic Field. (2) A New Class of Definite Integrals.—Prof. G. N. Watson: The Product of Two Hypergeometric Functions.—Prof. W. H. Young: (1) Integration over the Area of a Surface and Transformation of the Variables in a Multiple Integral. (2) A New Set of Conditions for a Formula for an Area.
ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.15.—Dr. Max Porges: Mud Baths and Nephritis.—Dr. F. Hernaman-Johnson: The Importance of Combined Methods in Diagnosis and Treatment.—Dr. S. Burridge: Some Possible Ill-effects of Barium Waters.
INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Adjourned Discussion on Papers by W. B. Woodhouse and R. O. Kapp on The Distribution of Electricity and Some Economic Aspects of E.H.T. Distribution by Underground Cables.
ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Dr. F. Buzzard: Tabes, its Early Recognition and Treatment.

FRIDAY, DECEMBER 10.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in the Botanical Theatre, Imperial College of Science), at 2.30.—Exhibition of Specimens and Short Communications.—W. J. Dowson: Problems of Economic Biology in British East Africa.—Dr. M. C. Rayner: Nitrogen Fixation in the Ericaceæ.
ROYAL ASTRONOMICAL SOCIETY, at 5.
PHYSICAL SOCIETY OF LONDON, at 5.—J. St. V. Pletts: Some Slide Rule Improvements.—F. H. Newman: The Absorption of Gases in the Electric Discharge Tube.—F. H. Newman: A Sodium Vapour Electric Discharge Tube (with Demonstration).—N. A. Allen: The Current-Density in the Crater of the Carbon Arc.
ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.
INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.
TECHNICAL INSPECTION ASSOCIATION (at Royal Society of Arts), at 7.30.—Dr. G. H. Gulliver: Some Features of Tensile Fractures.
ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.

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NATURE

THURSDAY, DECEMBER 9, 1920.

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The Dye Industry.

FOLLOWING on the agreement which has at last come about between the dye-makers and the dye-users, the Cabinet decided, on December 1, to introduce a Bill for the protection of British dyestuffs. This was promptly presented to the House of Commons on December 2 by Sir Robert Horne, President of the Board of Trade, read a second time this week on Tuesday, and is expected to be passed into law before Christmas.

The Bill is quite short, and prohibits the importation into the United Kingdom of all synthetic dyestuffs, colours, and colouring matters, and all organic intermediate products used in their manufacture, for a period of ten years and no longer. The Board of Trade will, however, have power by licence to authorise the importation of any of these products, and for the purpose of advising it with respect to the granting of licences a Committee will be constituted, consisting of five persons concerned in the trades in which the above goods are used, three persons concerned in the manufacture of such goods, and three other persons not directly concerned in the production or use of dyes. One of the latter three persons will be chairman of the Committee. The Board may charge in respect of a licence a fee not exceeding 5*l*. The Act will not apply to goods imported for exportation after transit through the United Kingdom or by way of transhipment.

If, as is expected, this Bill is passed into law the British dye manufacturer will be relieved that the promises of the Government have been redeemed, and he may now set himself with redoubled energy to secure that his products are beyond reproach, and to erect plant for the manufacture of dyes not yet produced here, which are urgently wanted by the dye-users. Such will, no doubt, be imported under licence for a time, but a period of ten years should be ample for establishing in this country a great industry which will provide every possible requirement of the dye-user, and a combination of chemical manufacturers, if it can be brought about, ought to place the economic position of this industry beyond fear of attack.

The great advantages to be derived from co-operation in the dye industry, so well indicated by the great German combination, the "Interessengemeinschaft," have evidently been realised in America, for, according to the *Times* of December 1, five of the largest chemical works in the United States—namely, the General Chemical Co., the Semet Solvay Co., the Solvay Process Co., the Barrett Co., and the National Aniline and Chemical Co.—are to merge their interests, and the combination is to possess a capital of about 60,000,000*l*. This sum is about as large as that of the German Trust, but the scope of the American company will be rather wider, including, as it will, the distillation of coal-tar, the fixation of atmospheric nitrogen, and the manufacture of heavy chemicals.

This is an important step in the direction of the consolidation of interests in America, and, in view of the protective legislation which is now being considered by Congress, everything points to the firm establishment of the dye industry in that country. The output of dyes is already high, being about 30,000 tons per annum, and the wide interest that is being taken in the field of industrial organic chemistry is further shown by the fact that there are nearly 200 firms engaged in the manufacture of crude products, intermediates, dyes, lakes, medicinal preparations, flavouring media, photographic chemicals, synthetic phenolic resins, synthetic tanning materials, and explosives.

It is much more important to give attention to developments of this kind than to over-emphasise the relation of the dye industry to war products in order to enlist the sympathy of the public for its protection. In an article in the *Observer* of December 5 Prof. H. E. Armstrong expresses the opinion that, had the dye-users taken active and financial interest in the British Dyes Corporation during the war period, the present situation would probably not have arisen.

Evolution of Water Plants.

Water Plants: A Study of Aquatic Angiosperms. By Dr. Agnes Arber. Pp. xvi+436. (Cambridge: At the University Press, 1920.) Price 31*s.* 6*d.* net.

WE have here a comprehensive work embodying the results of a ten years' study of water plants, and dealing in a very practical fashion with the mass of literature that has grown up around the subject. As a book of authority on aquatic plants, it will be ranked with Schenck's work of a generation ago, and it would not receive its due if we did not add that it worthily holds the place. But we must not forget that other industrious investigators have in the meantime filled the gap. Prominent among them are Gluck, Goebel, Henslow, Pond, Sargant, Sauvageau, Willis, and many others. Since Schenck's time, however, new points of view have arisen, and new methods have been in use by numerous inquirers of both sexes, all keen in their desire to take a part in the new era of research.

Yet we find ourselves in an age of unrest and uncertainty in the botanical world. There is a note of discord in the rivalry of the two schools of thought that are divided between the respective claims of the present and the past, or, rather, of the last and first stages of the evolution of the higher plants, to occupy the attention of the investigator. Dr. Agnes Arber speaks of "the deep obscurity involving all evolutionary thought" in our own day, and demurs to the objection that when we cannot even be sure as to the origins of the numerous varieties springing up under our eyes it is not a time for discussing the origins of Dicotyledons or Monocotyledons. In this she is impugning the policy of restricting our efforts to the study of the last stage in the unfolding of the story of plant life. So we get the keynote to her book, the first six-sevenths of which are regarded by her as "a clearing of the ground for the more theoretic considerations concerning the evolutionary history of water plants." But inquiries into their origin must necessarily raise great issues affecting also their relatives on the land; and thus we find in our hands a book that in its general bearings will give birth to much serious thought.

Yet, apart from theory, we have here a very extensive record of observation, experiment, and research on aquatic plants and their ways. The practical side, as we have seen, occupies by far the greater part of the work, and there is a wealth of illustration, mostly original. Quite a third of the space is devoted to the life-histories of the various groups of aquatic flowering plants, and these are followed by discussions on heterophylly, the morphology and anatomy of stems and leaves, the relation of the flowers to their environment, the wintering of water plants, the physical factors in their conditions of existence, and several other matters.

Taking our cue from the author, we will pass on to notice the more speculative portion of her book. There is first the question which might be placed among the "posers" little children are supposed to put. A primitive question about a primitive issue is concerned with the priority of the land- and the water-plant. As usually happens, the problem needs a good deal of straightening out before a reply can be made. Whilst it is generally recognised that the primeval forms were lowly aquatic plants, and that it is only in the higher plants that the terrestrial habit has become firmly established, we are far from being in a position to connect the one with the other.

Botanists are agreed that the aquatic Angiosperms are derived from terrestrial ancestors, but a cleavage in opinion began when they differentiated between Monocotyledons and Dicotyledons. Nature seemed to differentiate between them, and, being impressed by the preponderance of aquatic families among the Monocotyledons, botanists accredited the class with special aquatic proclivities. After considering the matter more closely, the author forms the opinion that these tendencies are hard to maintain.

Continuing to treat aquatic Angiosperms in the mass, and heeding only the systematic distribution of aquatics, the author lays down the principle that when a single genus or a species in an otherwise terrestrial family has taken to aquatic life, the habit may be a recent one; but when a whole family holding several genera is aquatic, we are dealing with a very ancient group of water plants where "the differentiation of the genera has occurred since the adoption of the aquatic habit." There are, in fact, "aquatics, new and old"; and they tend to choose their places in the systematic scale according to their age, the more ancient among the more primitive of the Angiosperms, and the more recent among those more advanced.

To the query as to which are the most primitive of the Angiosperms, the answer is: The families that are held within the Ranalean plexus. Those numerous families that go largely to form the Incompletæ of Bentham and Hooker, and which Engler places at the beginning of the Archichlamydeæ in the scale of development, are regarded as the more advanced and reduced forms of that series. Dr. Newell Arber, who supplied the original impulse for this work, laid the foundation for the author's position in this respect, and Miss Sargant's derivation of the Monocotyledons from the primitive Ranalean plexus is here accepted.

An explanation of the great structural reductions involved in the transition from terrestrial to aquatic life, and in the transference by hypothesis of so many families from the beginning to the end of the series of the Archichlamydeæ, became a necessity; so the author proposed her "Law of Loss," which has proved to be related closely to Dollo's "Law of Irreversibility" for animals. This rests on the principle that what is lost in the course of plant evolution can never be regained, and, if required again, "must be constructed afresh in some different mode." From this point of view the leaf-blades of several aquatic plants would be regarded as expansions of the petioles, and much light would be thrown on the many difficult questions involved in the interpretation of the flowers.

The author's position regarding natural selection is discussed, so far as it is determined by aquatic plants. The principle is almost protean in its appearances. When we think we have disposed of it in one shape, it arises in another. If, like Dr. Willis, we exclude it in the case of the genera and species of the Podostemaceæ, it turns up again as the principal factor in the adaptation of the group for life in rapid waters. Dr. Agnes Arber shares with many others her difficulties in accepting whole-heartedly the principle May it not be possible to assume that these difficulties would disappear if we broadened the basis of the theory? Whilst supporting Darwin through so many years, Hooker was holding a view of divergence, under the name of "centrifugal variation" (really a conception of differentiation), that was directly opposed to important points of the theory. Yet he considered that the greatest hope of the investigator lay in the *general* lines marked out by Darwin.

However that may be, we are reminded by the author of this book of an evolutionary idea, both old and new, that is capable of great development. The principle that what organisms gain in specialisation they lose in plasticity presents us with quite another way of viewing evolution—a view in which progression offers itself as a succession of lost opportunities. Progress in one direction involves the closing of the gates in "countless other directions," the possibilities of choice ever narrowing as we go up the scale. It is suggested that this would be impossible but for the inheritance of acquired characters, bound up, probably, with the inheritance of unconscious memory. At all events, it presupposes a primeval era of plasticity in which heredity had but little power. The line of thought is similar to that followed by Beccari in his theory of plasmation. Here a long vista opens up, and at its distant end lie the problems connected with the origin of the great groups of the plant world.

H. B. GUPPY.

The Behaviour of Beetles.

The Glow-worm and other Beetles. By J. Henri Fabre. Translated by Alexander Teixeira de Mattos. Pp. viii+488. (London: Hodder and Stoughton, Ltd., 1919.) Price 8*s*. 6*d*. net.

THIS is the second volume on beetles in the complete English edition of Henri Fabre's entomological works. The first essay, "The Glow-worm," which gives its name to the book, did not form part of the "Souvenirs Entomologiques," but was written for translation into English towards the close of the veteran naturalist's life. Several chapters, like this first one, have already seen the light in English, but most of the book is fresh, and it is very convenient to have the studies on beetles brought together. Eventually there will be four volumes on beetles. The experienced translator, Mr. Alexander Teixeira de Mattos, has done his work with great skill.

These are wonderful stories. The glow-worm tweaks a snail with its sharp mandibles, and administers an anæsthetic; a number of other glow-worms hasten to the repast and fall to; the flesh is converted by exuded ferment into a sort of gruel, and the fluid is sucked up by the hollow jaws. We suspect that there is some inaccuracy in Fabre's account; it seems clear, for instance, that the fluid food enters the gullet by the mouth, and not *via* the mandibles. In any case, Fabre's observations must be compared with those of Bugnion and Miss Kathleen Haddon. In regard to the luminescence Fabre was cautious:—

"From start to finish, the glow-worm's life is one great orgy of light. The eggs are luminous; the grubs likewise. The full-grown females are magnificent light-houses, the adult males retain the glimmer which the grubs already possessed. We can understand the object of the feminine beacon; but of what use is all the rest of the pyrotechnic display? To my great regret, I cannot tell. It is and will be, for many a day to come, perhaps for all time, the secret of animal physics, which is deeper than the physics of the books."

The close of this frank admission of ignorance has the characteristic Fabre touch, the precise point of which is not very obvious. Bio-chemistry and bio-physics are both very young, but they have already had their triumphs, which pass automatically into the contemned books. What is wrong with the physics of the books except that naturalists do not read it?

The succeeding five chapters deal with the remarkable life-histories of sitares, oil-beetles, and the like, and they certainly demand the reader's close attention. It is easier to follow the fine study of the capricorn (the grub of the Cerambyx beetle), which burrows in the stem of the oak.

"This grub, so poor in sensory organs, gives us with its prescience no little food for reflection. It knows that the coming beetle will not be able to cut himself a road through the oak, and it bethinks itself of opening one for him at its own risk and peril. It knows that the Cerambyx, in his stiff armour, will never be able to turn and make for the orifice of the cell; and it takes care to fall into its nymphal sleep with its head to the door. It knows how soft the pupa's flesh will be and upholsters the bedroom with velvet."

Here we have an instance of Fabre's strength and weakness; the facts are so interesting; the discovery of them was a triumph; the exposition of them is extraordinarily vivid; but the interpretation seems wildly anthropomorphic. We do not, we confess, understand instinctive behaviour; but we feel sure that the "inimitable observer," as Darwin called him, was off the scent. We get tired of this "knowing" and "bethinking," all the more because we doubt whether Fabre believed in it himself. "It knows the future with a clear vision," he says, "or, to be accurate, behaves as though it knew the future." But even this wobbling between inaccurate and accurate expression might have been accepted with good humour—a little fly in the fine ointment of fact for which every naturalist is grateful—had not Fabre made us wince by such *obiter dicta* as "now that the evolutionists' interpretations of instinct have been recognised as worthless."

One of the fine qualities of Fabre's essays is the way in which they raise questions which we cannot answer. How is it that the sawfly Sirex, which undergoes metamorphosis not far from the centre of the trunk of the tree, makes its way out to the light by the shortest route? Over and over again we find these puzzling problems stated; one attempt at solution is tested and then another, only to be rejected; and then the author gives it up for the time being: "I leave the matter to the conscientious masters, to the experts who are able to say: I do not know." This is much more educative than a prejudiced dismissal of evolutionism.

Biologically of great interest is the essay on insect colouring, in which Fabre expounds and illustrates the theory that various bright colours are due to a utilisation of ammonium urate or some related nitrogenous waste-product.

"While the larvæ of the Hunting Wasps, unable to do better, stipple themselves with uric acid, there are plenty of industrious creatures that are able to make themselves a superb dress by preserving their excretions in spite of their own open sewers. With a view to self-embellishment [again the anthropomorphic taint], they collect and treasure up the dross which others hasten to expel. They turn filth into finery."

When he got hold of an attractive idea, Fabre often let himself go, and we like him none the less for that.

"Nature, that sublime economist, delights in these vast antitheses which upset all our conceptions of the values of things. Of a pinch of common charcoal she makes a diamond; . . . of the filthy waste products of the organism she makes the splendours of the insect and the bird. The metallic marvels of the Buprestis and the Ground-Beetle; the amethyst, ruby, sapphire, emerald and topaz of the Humming-Bird; glories which would exhaust the language of the lapidary jeweller: what are they in reality? Answer: A drop of urine."

It seems almost profane to ask how many of the pigments of birds are known to be chemically related to urates; it seems niggling to ask whether the picturesque reference to sapphire and emerald is relevant at all, since these particular colours in the humming-bird are surely due to physical sculpturing rather than to any number of drops of urine.

The Fabre we like best is the patient and ingenious and sympathetic observer who tells us, in other chapters, of the accomplishments of the burying-beetles and their not less marvellous limitations, of "death-feigning" in Scarites and Buprestis, of animal hypnosis at higher levels, of the supposed suicide of scorpions, and of the *vie intime* of half a hundred beetles. Was there ever such an observer? We suppose Réaumur and two or three others might be mentioned. But was there ever any other observer of this rank who could tell his story so that we fancy ourselves seeing what he saw? We know of none. And so we come back to our homage to Fabre.

Kinetic Theory.

A Kinetic Theory of Gases and Liquids. By Prof. R. D. Kleeman. Pp. xvi + 272. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) Price 16*s.* 6*d.* net.

THIS book deals mainly with the "free path phenomena" in the kinetic theory of gases, but this department of the subject is comprehensively treated. Whether the chief object of such a work—namely, to gain some information about the intermolecular forces—can ever be attained without taking account of the other parts of the subject seems somewhat doubtful.

The body of the book is concerned with the various forms of transfer which occur in gases and liquids—transfer of energy or heat conductivity, transfer of momentum measured by the viscosity, and transfer of matter as evidenced in diffusion. Some ten years ago it might have seemed that it was in these properties, which are a measure of the free path, that the key to the riddle of molecular interaction was to be found. To-day, one is inclined to feel, they have been overemphasised when such a subject as the law of equipartition of energy is given only a couple of pages, and the fundamental problem of the reason why it breaks down is not considered at all. In particular, a statement (pp. 32-33) that "it is unnecessary and futile to endeavour to establish the law of equipartition of energy on assumptions relating to the interaction of molecules, when the law follows directly from the fact that a molecule is continually radiating heat energy," should really not occur in a modern book intended for university readers. The statement entirely begs the question of defining the temperature. The "fact," if such it be, should be established by more adequate proof than by a reference to the hot air rising from a surface, and the main point—namely, that the law which is represented as so obvious, in reality does not hold—should be mentioned. Far from being "unnecessary and futile," it is one of the most urgent problems in physics to examine why a law which can be proved to be a necessary consequence of the most general assumptions in dynamics should not hold in actual practice.

Apart from these and allied problems—*e.g.* the chemical constants of substances and the change in the ratio of the specific heats of hydrogen at low temperatures—the kinetic theory is admirably treated. Even the kinetic theory of electrons in metals is developed, though it is to be regretted that the essential fallacy of treating these as a perfect gas is not emphasised, and the uninitiated reader is left to believe that there are $2\cdot10^{24}$ free electrons per unit volume, when such a number would involve a specific heat about fifteen times as great as is actually observed.

In spite of these omissions, however, the book is certainly to be recommended, especially to those who are interested in free path phenomena, although these alone are scarcely able to throw light on the process of molecular interaction until the quantum problem has been solved.

A Monograph on Margarine.

Margarine. By W. Clayton. (Monographs on Industrial Chemistry.) Pp. xi + 187. (London: Longmans, Green, and Co., 1920.) Price 14*s.* net.

CURIOUSLY enough, the introduction of artificial butter dates from the early days of the Franco-Prussian War, and, while the butter and lard substitute industry has been carried on on a small scale since then, margarine, as an industry, became of prime importance to the nation only during the Great War. Many important improvements have been made, and these are set forth in the book under review.

In the first part a brief account of the oils employed in the manufacture of margarine is given, and some less known oils, such as Cohune oil, tea-seed oil, and Babassu kernel oil, are mentioned. Later chapters deal with hydrogenised oils, and for the present writer's views on this subject reference may be made to the notice of Dr. G. Martin's book on "Animal and Vegetable Oils, Fats, and Waxes" in NATURE of September 9 last.

Interesting chapters treating bacteriologically of the pasteurisation of milk and of the production of "starters" for the ripening of the milk follow. A brief description of the actual manufacturing operations of forming an emulsion between the mixed oils and the milk is then given. The theory of emulsification is, of course, very well stated, as Mr. Clayton is an authority on colloid chemistry. His opinions are therefore of great interest, and when they have been digested by technical chemists, very valuable results should arise in their industrial application.

In regard to the causes of rancidity in fats, Mr. Clayton seems inclined to accept the view that they result from bacterial actions on the glycerides. We believe that rancidity is due, in the first instance, to the formation of super-oxides of the unsaturated glycerides and their subsequent decomposition with the production of aldehydes and aldo-acids by the action of moisture, aided, perhaps, by the growth of micro-organisms. It would be out of place, however, to develop these views here.

The chapters on the analysis of margarine, etc., contain little to comment upon, except that enough stress is not laid on the iodine value and the hexabromide tests. In the portions dealing with nutritional chemistry the author gives a welcome review of the work done and of the opinions held by medico-chemists on the so-called "vitamines," "food hormones," "accessory food factors," "sitacoids," and "advitants." These are "substances" which are supposed to be present in, and give digestibility to, natural fats, and to be absent in prepared or artificial fats. The medico-chemist has thus named them. As Goethe says:—

> Denn eben, wo Begriffe fehlen
> Da stellt ein Wort zur rechten Zeit sich ein.

Blessed words! Not one of these so-called substances has been isolated, and no one knows their chemical formulæ or characters. Why a "substance" and not a "condition" of a known substance—say, a peroxidised form of some fat? Mr. Clayton seems to see this, and that the whole matter needs consideration from the chemical rather than from the medical point of view, for he states that the term "vitamine" is wrong, as no nitrogen has ever been detected in any of these alleged substances.

The book contains thirty-five pages of bibliography, and a patents index, and should prove of great assistance to food and emulsion chemists.

HARRY INGLE.

Our Bookshelf.

Le Parc National Suisse. Par S. Brunies. Traduit par Samuel Aubert. Pp. 274. (Bâle: Benno Schwabe et Cie, 1920.) Price 12 francs.

THE map of the Swiss Topographic Survey, on the scale of 1 : 50,000, forms part of this attractive publication. The reserve, established by the Federal Government in 1913, occupies a mountainous district trenched by two tributaries of the Inn. The best approach is by Zernez in the Lower Engadine, and the carriage-road to the Münstertal passes across the park. The author's description, translated from the original German, is picturesque and vivid; but the features that appeal to the visitor trained in scientific pursuits are always kept in view. Special chapters deal with geology and natural history, and the studious revival of the local Latin dialect is recognised by the stress laid on "romand" names. Pronunciations and a list are considerately furnished, and the careful translator informs us that the pronunciations given are those used in at least one village—that of Sinuos-chel. Great praise must be given to the illustrations. Apart from the four exquisite photogravures of the scenery of the park, Mr. H. Pfendsack of Pontarlier has supplied vigorous line-drawings of animals and plants, in every case connecting the subject with its stern environment. Compare, for instance, his *Pinus montana* (p. 149), recumbent but undefeated, clutching at the rock, with the climbing birds enjoying themselves as *alpinistes* on p. 217. He represents with equal insight the family life of the ibex, which it is proposed to restore to its former haunts, and the prolific poppy growing from a heap of stones. The author has well represented the history of the Alpine overfolds by successive sections. It is a pleasure to possess his book.

G. A. J. C.

(1) *Easy Lessons in Einstein: A Discussion of the More Intelligible Features of the Theory of Relativity.* By Dr. Edwin E. Slosson. With an article by Albert Einstein and a bibliography. Pp. vii + 128. (London: George Routledge and Sons, Ltd.; New York: Harcourt, Brace, and Howe, 1920.) Price 5s. net.
(2) *From Newton to Einstein: Changing Conceptions of the Universe.* By Dr. Benjamin Harrow. Pp. 95. (London: Constable and Co., Ltd., 1920.) Price 2s. 6d.
(3) *Die Einsteinsche Relativitätstheorie.* By Prof. U. Kopff. Pp. 24. (Leipzig: Greszner und Schramm, 1920.) Price 1.50 marks.

(1) DR. SLOSSON gives us in his book a breezy account of what he calls the more intelligible features of the theory of relativity with popular illustrations of distorting mirrors, references to Mr. H. G. Wells's "Time Machine" and other scientific romances, diagrams purporting to portray a four-dimensional cube, and general good-humour—a book with which the absolute layman may amuse himself for a few hours.

(2) Dr. Barrow gives a more serious, but equally readable, summary of the development of physical science from the mechanical period of the eighteenth century through the electrical theories of the nineteenth to the present day. Here also the layman will find profitable reading.

(3) The little pamphlet by Prof. Kopff is a reprint of a lecture on the relativity theory to the Natur-historisch-Medizinischen Verein at Heidelberg in June, 1920.

Technical Handbook of Oils, Fats, and Waxes. By P. J. Fryer and F. E. Weston. Vol. i., *Chemical and General.* Third edition. (The Cambridge Technical Series.) Pp. xii + 280 + xxxvi plates. (Cambridge: At the University Press, 1920.) Price 15s. net.

THE changes occurring in the industrial situation have caused the authors to add a certain amount of matter, and to make a number of alterations in the text of the first edition, which was reviewed in NATURE of January 17, 1918. Another addition has been made in the form of analytical data inserted in the text, and a number of footnotes, chiefly giving references to original papers, are now included.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Name for the Positive Nucleus.

A NAME is wanted for the fundamental unit of matter, which is also the unit of positive electricity as at present known. The name "electron" is best limited to the unit of negative electricity, about which a good deal is by this time known. Less is known about the positive unit, but it appears to be the brick of which all atoms are built up, electrons acting as cement. Nearly all the mass belongs to the positive unit, and the simplest atom—namely, hydrogen—appears to consist of one positive and one negative unit electric charge. The heaviest atom known has ninety-two such charges, and among the chemical elements are all intermediate grades. Prout's famous hypothesis that every element was a multiple of hydrogen is thus, with some modification, being confirmed, though the unnamed unit is not exactly an atom of hydrogen, but the nucleus, the main substance, of that atom.

At the Cardiff meeting of the British Association Sir Ernest Rutherford suggested, or tentatively approved the suggestion, that the name "proton" should be applied to this hydrogen nucleus or unit of positive charge. To call it a positive electron is undesirable—that name might be assuming too much—for it is just conceivable that the progress of discovery may detach from the proton a positive charge more closely akin to the negative electron—in fact an image of it. (It is not clear why a positive unit should differ so markedly, as at present it does, from the negative unit.) But, whatever the proton's relation to positive electricity, and whatever its constitution may be, it seems undeniable that it is the most essential and massive ingredient in every atom of matter.

From the scientific point of view the name "proton" is therefore good, for it signifies a fundamental substance and conveys a suggestion of Prout. But from the literary point of view there may be some objection, and a name for the foundation-stone of the material universe ought to be capable of being used in poetry, as the word "atom" has been used. It would seem well, therefore, to ask for suggestions before any name is adopted and allowed to get into general use.

Added Later.—Before sending in the above explanatory note I consulted some men of letters, who will, I hope, allow their names to be mentioned, and who have made some excellent suggestions:

AMBRON, as an English version of *electron*, suited to the unit of positive electricity.

MERRON, a conventional modification of *μέρος*.

UR-ON, or something based on the root Ur-; or even UR itself.

PRIME, as a primordial substance irresolvable into factors.

CENTRON, as a nucleus round which things revolve.

HYLON, as the fundamental unit of matter.

Of these I personally prefer *Hylon*; it serves to convey a fact with a minimum of hypothesis; it is itself a convenient word, and it surely need not be regarded as too metaphysical. If its first syllable suggests a real, but painfully illegitimate, relationship to hydrogen, that may be for it or against it, according to taste. I find the word "proton" is not liked; it has been described as "used up and very dull." Wrong pronunciation may be hostile to "Ur," and, besides, it might be confused with the other end of the series (uranium), though otherwise it shares some of the advantages of the happily invented word "gas."

OLIVER LODGE.

The British Association.

THE correspondence in NATURE under this heading has been most instructive. The widely spread feeling that the Association fails as an organisation to promote the growth of the scientific spirit could not well be more definitely brought to light, particularly as many who are known to hold strong views have refrained from expressing them; unfortunately, moral indecision is fast becoming a characteristic of our class. It is all very well for the late secretary and the present holders of the office to hint that the recommendations cancel out; maybe they are different; nevertheless, excepting our dear old member, Father Cortie, who has the sense of humour on all occasions, everyone agrees that the Association does not touch the public.

The most serious contribution to the discussion, that of greatest import, is the frank statement by the secretary of the Press and Publicity Sub-Committee at Cardiff—for once a man who dares to give open expression to the views he has formed—that we were in no way worth what we cost the locality; he has voiced a whisper, not seldom heard at previous meetings, which has long weighed on the conscience of some members of the Association.

The least satisfactory letter is that of the two secretaries, who are merely apologetic, in no way constructive. The manner in which, in their opening paragraph, they quietly imply that they are "It" would be amusing were the issue not so serious. Majestically they tell us to send *them* our views and that *they* will consider them. No doubt—and consign them to the waste-paper basket, as of yore.

Even outsiders see that science is losing its influence. Dean Inge, in one of his recent outspoken addresses, pointed out that "a general revolt against the dictatorship of science had been the most remarkable tendency in modern thought. In politics the anti-scientific temper was rampant. The revolution which more than a hundred years ago guillotined Lavoisier, 'having no need of chemists,' was now proclaiming that it had no need of intellectuals of any kind. In Russia they had been tortured and massacred; in our own country they were ignored and despised."

Ephemeral writers such as Mr. G. K. Chesterton openly scoff at us and lead the public to believe that evolution is a theory of the past and eugenic doctrine moonshine. Their word is accepted, ours is not; the clown is ever popular, the comic actor always preferred to the tragic; if we will assume only the prophet's mantle we must expect to be stoned.

It is useless for Sir Ray Lankester to take such men across his knee and thwack them in his best grandfatherly style. The literary braggadocio is only to be silenced by showing him up as ridiculous; he is but playing a part—writing nonsense because it pays; it is his trade and we must not blame him but blame the school in which the class is bred and has its being. We are too conceitedly serious, hopelessly narrow in our outlook, too self-centred to be alive to public needs—so individualised and so hopelessly jealous among ourselves that we will not co-operate and organise our forces. Nothing could show this more clearly than the way in which the Royal Society has sacrificed its opportunities during the war period by failing to bring all its fellows together and thus make our corporate influence felt. Little wonder that science is being more and more excluded. We are talking of government by public opinion but real opinion cannot be made public. The columns of the Press are not open to any serious discussion from our side; the books we write are not understood even by ourselves. Owing to excessive specialisation we are becoming less and less able to express and protect ourselves, less interested in stating our case in any broad way; what is worse, too selfishly immersed each in his own narrow occupation to consider the general interest: an we bé not careful the position won for us by the protagonists of the past will soon be lost to us.

Our failure is as window-dressers; we have not displayed our goods in the right manner. When a business is a failure, the only way to re-establish it is to reconstruct the management. That we have yet to learn this elementary truth is clear, however, from the recent appointment to the treasurership. A young man should have been found for the office, gifted not only with scientific experience but also with some breadth of outlook, some understanding of men and affairs; instead, a senior member of the Association has been chosen.

If a senior were desirable, no better choice could have been made; but I believe my old friend Principal Griffiths will not mind my saying that he is saved from inclusion in my class of elderly amiables only by the fact that throughout the war he was conspicuously active in his efforts to bring the value of scientific method before the public; he is far too soft-hearted to face the exigencies of the present situation.

The council must cease to be all but entirely an old or even an elderly man's show; responsibility must be forced upon the younger generation of active workers.

The secretaries obviously have no policy; new men must be chosen at the earliest possible date—I trust on the three years' hire system advocated in my former letter, so that the different subjects may be cared for at shorter intervals.

The real question at issue is: "How are we to get at the public?" To do this we must look beyond the meetings and in some way arrange for the preparation and issue each year of a few authoritative tracts dealing with bedrock problems in language that can be understood by all. Subjects can easily be found; under E alone enough are to hand—*Economics*, *Education*, *Energy*, *Entomology*, *Eugenics*, *Evolution*. Nobody believes in these, few know what the terms comprise, yet the future of our race depends on an intimate understanding and application of the doctrines they cover. A great work would be done by the Association if only, by real discussion not the dreamy, introspective twaddle of Section L, the nonsense now spoken of as education were reduced to terms of wisdom.

HENRY E. ARMSTRONG.

The Constitution of the Elements.

SINCE my last letter under the above title in NATURE of July 1, experiments have been made with a few more elements. The work has been progressively more and more difficult, for it has not been easy to find volatile compounds suitable for use, and when found the very objectionable chemical properties of some of them have led to experimental trouble and disappointing results. Thus selenium, tin, antimony, and tellurium have so far yielded no result of any value.

Fortunately, iodine (atomic weight 126·92) gave definite and unmistakable effects. It proves to be a simple element of mass 127—a result satisfactorily confirmed by a single line at 142 corresponding to CH_3I, the vapour used in the experiments. This result has particular interest in view of the recent work of Kohlweiler (*Zeit. Phys. Chem.*, vol. xcv., 1920, p. 95), who deduces five isotopes of iodine, all of even integral atomic weights, and claims to have effected a considerable separation of these by diffusion.

Owing to the kindness of Prof. Collie and Dr. Masson in providing me with a sample of gas rich in xenon, I have been able to identify two more probable isotopes of that element and obtain trustworthy values for the atomic weights of the five already found. The provisional figures given for these turn out to be too low. The values quoted below were obtained from the position of the second-order line 64·5. They should be trustworthy to about one-fifth of a unit.

Additional evidence on argon leads to the conclusion that its isotope 36 need no longer be regarded as doubtful.

The following table gives the results to date:

Table of Elements and Isotopes.

Element	Atomic number	Atomic weight	Minimum number of isotopes	Masses of isotopes in order of their intensity
H	1	1·008	1	1·008
He	2	3·99	1	4
B	5	10·90	2	11, 10
C	6	12·00	1	12
N	7	14·01	1	14
O	8	16·00	1	16
F	9	19·00	1	19
Ne	10	20·20	2	20, 22, (21)
Si	14	28·30	2	28, 29, (30)
P	15	31·04	1	31
S	16	32·06	1	32
Cl	17	35·46	2	35, 37, (39)
A	18	39·88	2	40, 36
As	33	74·96	1	75
Br	35	79·92	2	79, 81
Kr	36	82·92	6	84, 86, 82, 83, 80, 78
I	53	126·92	1	127
X	54	130·32	5, (7)	129, 132, 131, 134, 136, (128, 130?)
Hg	80	200·60	(6)	(197–200), 202, 204

(Numbers in brackets are provisional only.)

F. W. ASTON.

Cavendish Laboratory, November 30.

Solar Variation and the Weather.

IN NATURE of July 29 last (p. 678) appears an article by Dr. C. G. Abbot on solar variation and the weather, in which reference is made to the use of solar data by the Argentine Weather Service. Drs. Nansen and Helland-Hansen have also found some interesting correlations between the variations of solar radiation as measured by Dr. Abbot and variations of temperature and pressure in Norway.

As other investigators will no doubt be tempted into this field, I feel that it may be of interest to give briefly a summary of our latest results and conclusions. These conclusions are based on the study of an immense amount of data from various parts of the world, the results of which will be published in due time.

The first and most striking result is that the solar radiation exerts a cumulative effect on the atmosphere so that prolonged periods of high or low solar radiation have a much greater response in atmospheric action than shorter periods of greater intensity. Thus a deviation of 5 per cent. from the average radiation of short duration might not produce so great an effect as a long period, with a mean deviation of 2 per cent.

The second result is that as the sun changes from one hemisphere to another the effect on the weather changes, so that in the hemisphere where the sun is nearly vertical the pressure falls over the land surface and rises over the water surface, while the opposite effect is found in the other hemisphere. This effect I take to be a proof that a considerable part of the increased solar radiation reaches the earth's surface and intensifies the normal effect of absorption of solar radiation by the land. There are, however, clear indications that a considerable part of the increased solar radiation is absorbed by the upper air and gives origin to atmospheric waves which, if they are not the determining cause, at least are very influential in determining the discontinuities referred to recently in NATURE by Prof. Bjerknes.

These atmospheric waves are of a complex nature, and for this reason the correlations with solar changes are best seen by separating the solar and weather changes into shorter and longer (or slower) waves.

By taking averages of ten days we found for 1916 correlations as high as 84 per cent. with certain Argentine stations, and correlations exceeding 80 per cent. in later years. The shorter waves do not give such high correlations, apparently for several reasons, the most important, perhaps, being that there are still some errors in the solar values due to the difficulties of eliminating the effect of changing transparency of the air while the solar observations are being made.

This difficulty has undoubtedly been greatly diminished during recent months by the use of the pyranometer, which enables the observers to get measurements of the solar heat from a single bolograph. Certainly since this method was begun the correlations of the solar variations with atmospheric waves have increased. Another difficulty appears to be that while the waves start from definite centres of action, these centres shift position to some extent, so that the time interval of the effects following solar changes is variable, and this variability is of greater importance in the shorter waves.

The prolonged effects following unusually high or low values of radiation shown by Dr. Abbot's curves, reproduced in NATURE, I believe to result from the normal sequence of events on the surface of the sun. After a marked excess or defect of radiation there is likely to follow a similar deviation from the normal after an interval of ten to thirteen days.

This result I believe to arise from the fact that when there is a marked outbreak of heated solar gases on the edge of the sun, where absorption is normally great, the total radiation is more intensified than when the outbreak is near the centre. If the outbreak is near the edge it will be carried by rotation to the opposite edge in from about eleven to nineteen days, according as to whether the position is on the east or west edge.

In the same way cooled gases produce their greatest absorbing effects when near the edge of the sun, and there is the same tendency to repeat. These effects also tend to repeat themselves after a solar rotation, but in that case the interval is so long that marked changes have usually occurred. However, these repetitions are sufficiently numerous to make it practically certain from the length of the rotation that the conditions causing the marked deviation from normal are in the region of the prominences, and not in that of the sun-spots, which have a period of about twenty-seven days.

These studies of the relations between solar changes and the weather have been in progress in the Argentine Meteorological Office for several years, so that when a station of the Solar Physics Observatory of the Smithsonian Institution was opened in Chile, arrangements were made between Prof. G. O. Wiggin, director of the Argentine Weather Service, and Dr. Walcott, director of the Smithsonian Institution, for the transmission of the solar radiation measurements by cable to Buenos Aires and for their use so far as possible in weather forecasting. To this work Prof. Wiggin and the assistant chief have given enthusiastic support, and through their efforts, and as a result of a growing interest in the subject in Argentina, the Legislature has recently appropriated some 25,000 pesos for the installation of a solar observatory in Argentina.

The forecasts are made for a week in advance by publishing estimated temperatures for each day, and also forecasts of expected rains. With increased experience there have been steady improvements and an increasing demand for the forecasts by commercial interests.

There are many complexities which remain to be solved, and perhaps some which can never be solved, but I believe that a distinct advance has been made in forecasting, and the progress is too far advanced to be turned backward. One of the greatest difficulties is the inversion of the solar relation with the season, and occasional inversions for other reasons not yet clearly understood.

Heretofore, most of the studies by others in regard to the relation of solar changes and atmospheric phenomena have been in reference to the sun-spots. Dr. Abbot's observations indicate clearly that there is a change of solar radiation corresponding to the eleven-year sun-spot period. The radiation increases with the increase in spottedness, but this change is of relatively small importance compared with shorter changes of greater intensity.

Sir Norman Lockyer suggested some years ago that there were weather changes due to solar changes other than the eleven-year period, and brought evidence to show that a period of about four years in the outbreak of prominences caused atmospheric changes having the same period. But solar radiation shows a variability far greater than is indicated by the observations of prominences, and the high value of the correlation between these and the weather which we have found for the Argentine and for other regions of the world leads me to believe that these changes are the chief, if not the only, cause of weather changes as distinct from the well-known diurnal and annual periods.

H. H. CLAYTON,
Chief of Forecast Division.
Oficina Meteorológica Argentina.

The Physical Meaning of Spherical Aberration.

THE nature of the distribution of light round the axial focus of a lens is a problem which has frequently been attacked mathematically. It has been quite successfully solved for points in the principal focal plane of an "aplanatic" lens when the intensity is found to depend on functions of the form (assuming Huygens's principle)

$$\text{Intensity} = \text{const} \times J_1^2\left(\frac{2\pi k}{\lambda} \cdot \frac{a}{R}\right),$$

where J_1 is the Bessel function of the first order, R the radius of the wave-surface at the lens, a the semi-aperture, and k the distance of the point from the axis. At present it has not been found possible to give an expression for the light distribution in the presence of spherical aberration, or away from the focus, which can be physically interpreted in such a simple way. Prof. Conrady has been able, however, to determine the distribution numerically (Monthly Notices, R.A.S., vol. lxxix., No. 8) in a series of simple cases by mechanical quadratures which give the value of the integral

$$I = \text{const} \times \int_{a=0}^{a=a_1} \{J_0^2(\alpha a)\cos^2\eta_a + J_0^2(\alpha a)\sin^2\eta_a\} d(a^2),$$

where

$$\alpha = \frac{2\pi k}{\lambda R},$$

η representing the phase which is supposed to vary in a spherical reference-surface by an amount depending on the spherical aberration. Prof. Conrady assumes a series of likely cases for phase distribution. No analytical expression for η can be obtained for any but the simplest optical systems, but empirical expressions can easily be derived from the result of trigonometrical ray tracing or Hartmann tests in the most complex systems, thus enabling the truth of the numerical results for light distribution to be checked experimentally. The value of

$$\eta_a = \frac{2\pi}{\lambda} \int_0^a \theta da \text{ (very nearly)},$$

where θ is the angular aberration derived from the calculated or observed lateral aberration or lateral intercept due to displacement from the centre of the spherical reference surface.

It is not too much to say that the thorough solution of the problem is of the greatest importance in the study of the performance of optical instruments. In order to search for the actual phenomena predicted by Prof. Conrady in theoretical cases, and further to explore the subject, I have recently carried out a critical examination of the image of a very small source of light (a fine "pinhole" in a silver film) produced by a microscope objective having excellent spherical correction, and for which the curves, glasses, etc., were known. The spherical aberration introduced by varying the tube-length can thus be calculated for any conditions. A nearly linear relation was found between the phase difference of the paraxial and marginal rays at the marginal focus and the reciprocal of the tube-length.

As a check on the calculation, I was able to devise a method of performing a test on the microscope objective very similar to the well-known Hartmann test employed for telescope object-glasses. By this means the properties of the objective became well known.

The changes in the distribution of light at the best focus in the presence of varying amounts of spherical aberration have been examined quantitatively, both visually and photographically. A perceptible loss of light from the central disc, estimated at 20 per cent., occurs when the residual aberration at the best visual focus amounts to 0·25λ. Such light is scattered into the surrounding field; it does not appear in the first bright ring at this focus. The sizes of the rings in the diffraction pattern at the best visual focus do not depart measurably from the theoretical values in the presence of residual aberration amounting to 0·6λ at the focus where there is least confusion of phase.

The "out of focus" appearances present many points of great interest. It appears that the successive bright rings retain a marked individuality, but suffer periodic variations in brightness and "thickness." This causes the dark rings between them to suffer corresponding variations in "darkness" and in radius. Under a high magnification the familiar broad, dark diffraction rings which appear to grow in the expanding "out of focus" disc are found to grow as the result of this periodic motion of the smaller dark interference rings, the whole action resembling that of a model to illustrate the propagation of the compression waves of sound.

If, when the aberration is a minimum, we go sufficiently far out of focus to introduce a path-difference between marginal and paraxial rays, $dp = 0{\cdot}5\lambda$, on either side of the focus, we find that the first dark ring has nearly filled with light. At about $dp = 1\lambda$ the central disc has lost all its light, and the first bright ring is at a maximum. At about $dp = 1{\cdot}5\lambda$ the central disc has again reached a maximum, the first ring is at its minimum, the second at a maximum, and the third nearly equal to the second. We thus see the first broad, dark diffraction ring between the central disc and the annulus of light formed by the second and third bright rings. So the various changes progress, the location of the successive bright rings being given fairly nearly by the ordinary theory. When, however, a definite amount of *aberration* is introduced, sufficient to cause a residual variation of phase of 0·5λ at the best focus, the changes are violently dissimilar on the two sides of the focus—a fact which is fairly well known. On one side there is a quick dissolution of the central concentration into a mere haze, while on the other a bright and well-formed ring system is found in which the broad diffraction rings spread out with much the same action as before, except that the periods of the variations are altered from those in the "no aberration" adjustment. Further, on this side of the focus, as was suggested by Prof. Conrady's numerical results, a central concentration persists which diminishes considerably in size as compared with the "best focus" disc, but remains brighter than the rest of the ring system up to a path-difference $dp = 3\lambda$—a displacement in the actual focussing point of 7 mm. in a total tube-length of 23 cm. It can easily be seen that this effect is quite capable of rendering possible instrumental performances, so far as resolving power alone is concerned, far in excess of any value possible in the absence of spherical aberration, although this would be a perfectly legitimate conclusion only for such cases as that of a double-star resolution by a telescope objective. A fairly complete set of photographs to illustrate the various appearances has been made. These have been measured and examined for the purpose of intensity determinations.

The importance of these matters lies in the determination of the effects of aberration, expressed in ray intercepts, on the distribution of light in the image, as the distribution suggested by ray concentration is often nothing approaching the truth. The "out of focus" appearances, too, are of great importance in dealing with "roundness of field." It is possible, in the light of such results, to form ideas as to legitimate tolerances in design and manufacture.

The investigation, to become complete, must be extended to other types of aberration, but it is hoped shortly to publish a complete account of the experimental work, of which the foregoing *résumé* may give an idea of the scope. The photograph herewith shows the ring system when a residual aberration, in the sense of "over-correction," of 0·5λ is present at the best focus, and when the reference plane is taken sufficiently far outside the focus to make the path-difference $dp = 1{\cdot}8\lambda$. The small central concentration and the persistent individuality of the interference rings are shown. The first "broad" diffraction ring is now formed through the low intensity of the first bright interference ring. The whole of the above work relates to nearly monochromatic light only.

A good many of the broad features of these aberration and "out of focus" effects can be explained without difficulty on the basis of the Fresnel zone theory, and it is hoped to include a short discussion of this kind in the paper. No more need be said at present except to direct the attention of the readers of Nature to the importance of the paper on "Star Discs" to which the reference is given.

L. C. Martin.

Imperial College of Science and Technology,
November 25.

"Phenomena of Materialisation."

In Nature of November 18 I find what purports to be a review of Dr. von Schrenck-Notzing's work translated by me under the above title. I have always supposed that a reviewer should tell the reader what the book is about. The review in question is headed "The Newer Spiritualism," and begins: "'Of making many books' on spiritualism 'there is no end.'" It states that the phenomena are alleged to have "a spiritistic interpretation," and refers to "the numerous photographs of her [the medium] sandwiched between faked spirit photographs." All this is thoroughly misleading. The book is not about spiritualism. Both the author (p. 30) and the translator (p. x) discard the "spirit hypothesis" as unnecessary. The author says that "it impedes and hinders in every way serious scientific investigation." The book contains no portrait of the medium, and not a single "spirit photograph," faked or otherwise. The photographs reproduced have not been manipulated in any way except Nos. 127, 128, 134, 136, 138, and 140, in which, for purposes of publication, the sex characteristics have been obliterated. These six photographs are marked "retouched," and the reason for retouching is stated in the text.

The review abounds with other inaccuracies. A red light was not always employed (see p. 306). Mme. Bisson did not "hop in and out" of the cabinet. The rare occasions on which she entered it are stated, as are all the other conditions, with what the reviewer calls "dreary uniformity," but with what the ordinary scientific reader would call conscientious accuracy.

The reviewer's challenge to "exhibit" the phenomena in London before well-known hostile critics is about as reasonable as to ask a performing mouse to exhibit its tricks before an audience of hungry cats. The psychological element would probably produce similar inhibitions in both cases. The phenomena are nearly as rare as the fall of a meteorite from the sky, and nearly as spontaneous as the production of biological "sports." They cannot, therefore, be produced before a massed audience. It is useless to think that any living individual is eminent enough to carry a general conviction of the reality of the phenomena, even though he be personally convinced. The only resource is to take the phenomena as and when they come, to record them carefully, if possible by photography and other instrumental means, and to make the experimental conditions gradually more rigid until we can only conclude that we are face to face with a new set of biological phenomena exhibiting the known powers of the human organism in an intensified and much accelerated form. And this is precisely what Dr. von Schrenck-Notzing has done.

E. E. Fournier d'Albe.

It will be well to deal with Dr. Fournier d'Albe's charges against my accuracy *seriatim*:

(1) "Both the author (p. 30) and the translator (p. x) discard the 'spirit hypothesis' as unnecessary." I might have made this clearer, but the repudiation is not easy to reconcile with the contents of a book crammed with references to occult phenomena, as, *e.g.*, mediumistic, psychic, and telekinetic.

(2) "The book contains no portraits of the medium, and not a single 'spirit photograph.'" This is an amazing statement. There are 225 illustrations. Of these there are 13 "drawings," so-called; all the rest are flashlight photographs of the medium (if not, then of whom?) in various attitudes, a large number showing the teleplasma issuing from her mouth, etc. There are 20 flashlight photographs—"phantasms" they are called—of dead and living people. Among the former Mme. Bisson recognised the features of a deceased nephew, Georges Thurner, and also of her husband, who died in 1912.

(3) "A red light was not always employed (see p. 306)." "All the sittings took place in a red light, so that during the four years there was not a single dark séance" (p. 21). The translator may be left to reconcile this statement with the exception to which he gives the reference.

(4) "Mme. Bisson did not 'hop in and out' of the cabinet." Probably she neither hopped nor skipped, but her visits to the cabinet were frequent enough to arouse suspicion as to collusion with a medium over whom she had "absolute control" (p. 59). Dr. Fournier d'Albe does not appear to have been present at the sittings.

(5) "The reviewer's challenge" cannot be accepted because the phenomena cannot "be produced before a mixed audience. . . ." "We are face to face with a new set of biological phenomena." So long as those who assert their belief in teleplastic exudations from the body and in the genuineness of photographs of the dead refuse to submit these "new biological" phenomena to the conjoint judgment of men of science and conjurers, they must not be surprised that their so-called "evidence" carries no weight save among the credulous.

The Reviewer.

Higher Forestry Education for the Empire.

A correspondent has sent us some remarks upon Prof. Stebbing's letter dealing with forestry education in Nature of December 2, but he has omitted to give his full name and address. No use can, therefore, be made of his communication.—Editor, Nature.

Automatic Printing of Wireless Messages.

ONE of the recent developments in wireless telegraphy, which, as we have already announced briefly, was demonstrated by Mr. A. A. Campbell Swinton during his address on November 17 to the Royal Society of Arts, is the automatic printing of wireless messages in roman type. Several systems of printing telegraphy are in use on ordinary lines, but the ingenious method designed by Mr. F. G. Creed is, we believe, the only one that has been adapted to the printing of wireless messages. High-speed wireless reception in various forms is being used to an increasing extent, and Morse code messages are recorded by optical and mechanical methods, as well as by an instrument analogous to a phonograph; but the actual printing of the words in ordinary type on a paper strip presents obvious and very great advantages.

That this result has been rendered possible of achievement is mainly due to the greatly improved methods of amplification of the signals received now available, which have enabled current impulses of sufficient strength for the actuation of the necessary relays to be obtained from the minute oscillations in the receiving aerial. Briefly, the system consists in a combination of the existing printing telegraph apparatus designed by Mr. Creed with the latest arrangements of groups of thermionic valves such as those devised by Capt. L. B. Turner and other workers, who carried on important researches in this direction during the war.

In the Creed system, whether for wireless or line transmission, the message is first translated into the Morse code by punching a perforated strip of paper in an apparatus, with a typewriter keyboard, so contrived that each key perforates the strip, by a solenoid operated mechanism, with the Morse equivalent of the letter in question. This strip, exactly as in the case of automatic Wheatstone working, is passed through the transmitting instrument, which sends out current impulses in the ordinary way in the dots and dashes of the Morse code. These, in ordinary telegraphy, go direct into the line, but in wireless working they are used to actuate a special transmitting contact maker, forming the equivalent of a high-speed relay-operated Morse key. Messrs. Creed and Co. have developed several sizes of transmitters for this purpose, including one suitable for very powerful installations, worked by an electro-pneumatic relay arrangement, and capable of dealing with as much as 300 kw. This has eight sets of contacts in parallel, each breaking under a powerful air-blast.

The waves at the receiving station are picked up by a thermionic-valve receiver, and considerably amplified by a number of valves in cascade in the manner employed in connection with other methods of recording. Current impulses are thus supplied to the relay magnet, forming part of the apparatus known as the Creed receiving perforator. This is of the same form as that used in line telegraphy, and, as employed hitherto for wireless reception, is worked by compressed air, although the company is now developing an electrically driven pattern on a mechanical principle, which is simpler and more compact, and dispenses entirely with compressed air. The Creed air-engine relay used in the instrument is a very interesting piece of apparatus. The tongue of the electrical part of the relay, instead of operating electrical contacts, actuates a very small slide valve controlling a little auxiliary piston, which moves the slide valve of the larger main piston. This, by moving in one direction or the other, drives forward one or other of the perforating punches, through a system of levers.

A very ingenious device arrests the motion of the strip while the holes are being punched. The strip from the receiving perforator, which is still in the Morse code, is the exact counterpart of that used at the transmitting station, with holes side by side to indicate dots and staggered to represent dashes, and a continuous row of holes down the centre for feeding purposes. The arresting action is effected by a plunger being thrust forward between the teeth of a spur-wheel on the shaft of the feed-sprocket. The holes are punched opposite each other if the second punch moves forward soon enough after the first for this wheel not to have advanced a whole tooth pitch, so that the arresting plunger, in reaching the bottom of the space between the teeth, really brings the paper back a little way. On the other hand, if the wheel has advanced by a whole tooth pitch or more, the plunger engages in the next space, and the second perforation is advanced beyond the first. A Creed receiving perforator is seen in the centre of Fig. 1.

The perforated strip is then passed on to the Creed printer. The great feature of this remarkable piece of apparatus is that it forms an automatic typewriter controlled entirely by the position of the holes in the perforated strip, and translates Morse code into printed characters. It is impossible here to do more than to indicate the general principle on which the instrument works, although it is on the perfection of the design of details that much of its success depends. In Fig. 1 the strip from the perforator is seen passing direct to the printer, and a printer by itself is shown in Fig. 2.

The perforated paper strip is fed past a group of spring selecting needles, ten on each side, and when it is momentarily at rest with the portion corresponding to a letter opposite the needles, a certain number, forming a pattern corresponding to the letter, protrude through the holes in the strip. Each needle which has thus advanced causes, in a way indicated later, a change in the position of one of a pack of thin steel strips or sliding valve plates. These valve plates lie between two fixed perforated plates, and are themselves perforated in such a way that the position assumed for each combination of the selector

FIG. 1.—Complete receiving-printing apparatus, including receiving perforator with relay and printer.

needles corresponding to a letter in Morse on the strip causes coincidence of the perforations at one point only, so that there is a clear aperture through the whole pack in a position corresponding to a letter. The bottom plate is supplied with compressed air at the moment in the cycle of operations corresponding to the printing of a letter, and each aperture in the fixed top plate communicates with a small cylinder, in which moves a piston actuating one of the type bars, through levers like those of an ordinary typewriter. Thus a letter is printed corresponding to the position of the coincidence of the valve-plate apertures.

The arrangement whereby a variable feed is given to the strip, according to the length of the letter, is combined with that for actuating the valve plates in accordance with the selection made by the needles. A reciprocating feed-rack is provided, which, when required, can gear into a spur-wheel on the same shaft as the feed-sprocket. The length of its downward travel while out of gear depends upon the point where it is arrested by the projection of one of a group of spacing levers. Normally, these levers are pushed out of the way by the selecting needles, but where neither of a pair of selecting needles advances—*i.e.* where there is a space signal—a space lever continues to stand out, thus limiting the movement of the rack to the length of the letter. A sideways movement is then given to the rack, putting it into gear and causing the perforated strip to feed forward, by exactly the length of the letter just dealt with, during its return journey. Each selecting needle, as it advances, causes a hinged piece on the corresponding valve-plate extension to move forward and to form a shoulder by the side of the feed-rack, so that the sideways movement of the feed-rack is also the actual cause of the shifting of the selected valve plates. It was mentioned above that there are only ten valve plates, whereas twenty selecting needles are provided. It is only the lower group of ten needles that controls valve plates, but the remainder are required to actuate spacing levers. Although more selecting needles may pass through the strip than those corresponding to the letter in question, only the proper number of slide valves are acted upon by the rack, on account of the limitation of its travel by the spacing levers. There are several other features, including the method of withdrawal of the selecting needles and the timing of all the various operations by means of cams, which we cannot dwell upon. The whole apparatus, including a small attached air-compressor, is driven by an electro-motor, so that no external source of compressed air is required.

FIG. 2.—Creed type printer translating from perforated Morse strip.

Messrs. Creed and Co. have also developed an improved form of printer, in which compressed air is dispensed with, and the type characters are mounted on a circular disc and hit from behind by a little selecting hammer which is caused to stop at the part of the revolution corresponding to a letter by a circular group of selecting levers. This form of the apparatus is much more compact than the original instrument, and has a much higher printing speed; but we understand that it has not yet been adapted to wireless reception.

The Creed system with compressed-air working, as adapted to wireless reception, is capable of a speed of transmission of about 180 words a minute, which is in excess of the speed of the printer; so that, in order to obtain the full capacity, two printers would have to be installed for one receiving perforator. The improved printer, however, will be capable of keeping up with the receiver, even in its improved form, and will be able to deal with something like an increase of 50 per cent. in the speed of transmission. Apart from considerations of traffic, high transmission speeds present advantages in that there is more chance of the message being completed without interruption by atmospherics or other extraneous effects. Very successful experimental working has been carried out between Cologne and the War Office station at Aldershot, and a wireless printing equipment of this kind is to be adopted between Brussels and a large station in the Congo district.

The New Oilfield of Northern Canada.

By W. Jones.

CONFIRMATION has now been received from Canada of the news that an important oil-well has been obtained in the North-West Territory of Canada. The full significance of this event is only gradually being realised by the public. It is probable that this is the commencement of the development of the largest oilfield in the British Empire—possibly one of the largest in the world.

For several years it has been known that geologists had found a land of much promise in the north, but until now, owing to the difficulties of transportation, no drilling operations had been attempted. The well, which is situated on the banks of the Mackenzie River, 48 miles beyond Fort Norman, within a few miles of the Arctic Circle, is about 1000 miles N.N.W. from Edmonton. It is 1300 miles journey by water beyond the northern limit of the railroads. This is the "farthest north" oil-well in the world, and is some 500 miles distant from any previous drilling. (The nearest producing oil-wells are those in Alaska.)

Little detailed geological information about this part of the North-West Territory is available, but it will be remembered that a geological exploration of the Mackenzie River basin was conducted by a party of English geologists, led by Dr. T. O. Bosworth during the year 1914, on behalf of a Canadian syndicate. On the return of the expedition it was reported that a great oilfield region had been determined. At that time much interest was aroused by the discovery, but, owing to the war, less attention was paid to the prospects than they would otherwise have received. The present development is the long-delayed sequel, for, according to the particulars now received from Canada, the well is located on the oil-claims which were "staked" by the Bosworth expedition. These claims have since been acquired by the Imperial Oil Co., the geological department of which has been headed by Dr. Bosworth for a number of years.

The drilling machinery was sent north in 1919, and the well has been drilled on the site which was chosen in 1914 for the crucial test. The drillers stayed at their post throughout last winter, and the actual drilling commenced in the spring of this year. In the first 200 ft., useful quantities of a very high grade oil were struck, and at 800 ft., according to the report of the drilling party, the oil gushed up from the 6-in. casing in a column which rose 15 ft. above the top of the derrick. After half an hour the drillers capped the well, so that the oil may be preserved until storage tanks can be constructed. Until that time the well's exact yield will not be measured, but it is probable that it will produce a thousand, and possibly several thousand, barrels of oil a day.

According to the brief statement made in 1915 by Dr. Bosworth to the Institution of Petroleum Technologists (Journ. Inst. Pet. Tech., March, 1915), and also in the *Petroleum World* (February, 1915), abundant seepages of oil were found throughout a very large region occupied by the Devonian rocks, and "in that region all the geological evidences of oil conspicuously occurred." The source of the oil was a thick deposit of "black bituminous shales and limestones, which cover an area of enormous extent." "In some places the black shales were actually undergoing combustion at the present time, and in several places oil was seeping out into the water for distances of several miles." The structure also was favourable, for the region is traversed by a system of mountain building anticlines. In Dr. Bosworth's opinion "the discoveries which had been made were of the greatest importance," and "fields of the utmost promise had been marked out, bearing all the indications and evidences that an unexploited field could be expected to show."

The foregoing remarks, together with the splendid result of the first test well, are significant. On studying a geological map of North America it will be seen that the Devonian formation of the Mackenzie River covers a very large area, extending for hundreds of miles along the direction of the river. In the reported words of a geologist who accompanied the drilling party this year, "the biggest oilfield in the world is what has now been opened in the north."

Before this great oilfield can be made commercially profitable there are, of course, many difficulties to contend with, especially the long distance from civilisation, the severity of the Arctic climate, and the lack of adequate transportation. But as these obstacles did not prevent the exploitation of the gold in Klondike, we need have little fear but that this precious fluid in the Mackenzie valley will be won.

Several of the Canadian Geological Survey Memoirs describe the Mackenzie River district, though they do not enlighten us much on the subject of petroleum, which was the special object of the Bosworth expedition. The most interesting of these is the report by Mr. R. G. McConnell, published in 1891, which mentions the bituminous rocks and pools of tar and oil, which he observed in many places. Memoir 108, on "The Mackenzie River Basin," by Messrs. Charles Camsell and Wyatt Malcolm, which appeared in 1919, also cites particularly the oil indications which Mr. McConnell had found, some of which had been noticed also by Sir John Franklin a century ago. This official memoir is very guarded on the subject of petroleum, and does not afford great encouragement to oil prospecting on the Mackenzie; but it is a comprehensive summary of the previously established facts, together with many valuable observations, old and new.

During the next few months there can be little or no progress made with the development in this frozen land, but doubtless many preparations are afoot, and next spring will see an unprecedented migration of oilmen to this northern clime.

Industrial Research Associations.

V.—The British Portland Cement Research Association.

By S. G. S. Panisset.

ALTHOUGH the Portland cement industry had its origin in this country, the chief developments have occurred elsewhere, and the greater part of the manufacturing plant now in use is either of foreign production or a close copy thereof.

It may be disputed that this position has arisen from the absence of organised research in this country, but it is certainly true that the amount of scientific investigation in the British Portland cement industry has been insignificant compared with the work done in the United States and on the Continent.

With these circumstances existing, it is clear that the British Portland Cement Research Association is a needed institution, and it is some comfort to know that its arrival is not too late to be effective. The extent of the field of research still awaiting exploration is such that no agreed answer can be given to the fundamental questions, "What is Portland cement?" and "What happens when cement sets?"

In spite of the extensive research that has been conducted in the United States by Government institutions and by universities, the real nature of cement, and the chemistry and mechanism of its setting, are still matters of controversy, owing to the lack of concrete evidence.

The manufacture, in fact, is still in the empirical stage, based solely upon the knowledge that a mixture of calcareous and argillaceous materials containing about 76 per cent. of carbonate of lime will, when heated to incipient vitrefaction, yield a product which on grinding has pronounced hydraulic properties. Whether the hydraulic effect is due to the presence of simple silicates and aluminates of lime, whether complex ternary compounds exist, or whether a part of the lime is uncombined and in the state of solid solution, are all problems which must be solved before it can be claimed that the best possible constructional material is being produced.

In connection with the setting of cement, it is still undecided whether this is due to colloidal or to crystalline action, and the manufacturer is accordingly in the dark as to whether he ought to be aiming at the production of colloids or of crystalline bodies to produce the best results.

The composure of manufacturers has now and again been disturbed by predictions that cement can be made from a mixture containing only two-thirds the conventional proportion of lime, and again that the stage of incipient vitrefaction now produced in rotary kilns can be improved upon by adopting blast-furnace methods and carrying the temperature to melting point. From the point of view of scientific knowledge the manufacturer is unable to deny that such statements are within the range of possibility, and hence there is always the fear that more than half the present cement-making plant may be rendered obsolete by new discoveries.

This is not a happy position for an industry, especially when such a discovery is likely to be the property of those who have hitherto been foremost in research—namely, the foreign competitor—and in this connection the advent of the British Portland Cement Research Association is not a day too soon.

Again, if it be supposed that the present methods of manufacture are permanent, the fact has to be faced that the thermal efficiency of the kilns in use is seldom more than 50 per cent., and here is a field for research that may lead, upon cultivation, to a reduction in the cost of production. The importance of the matter to an industry consuming $1\frac{1}{2}$ million tons of fuel in a year can be readily appreciated.

It is obvious, therefore, that a very wide field lies before the British Portland Cement Research Association, and the scope both for scientific and for industrial research is ample warrant for the existence of the association for some years to come.

The British Portland Cement Research Association was incorporated in November, 1918, and had the advantage of being founded upon the research department of the two largest cement manufacturers in the country. This research department had been in existence for five years, and had gathered together an experienced staff and a valuable equipment of scientific apparatus, while the large amount of spade-work that had been done has proved of great value to the association. Both staff and equipment were taken over entire, so that no time had to be spent in organisation, and research was in progress from the first day of the association's existence.

The council of the association has addressed itself in the first instance mainly to the industrial side of research, and the chief activity has been the investigation of the thermal efficiency of rotary kilns. The basis of this investigation has been the fact that the consumption of fuel in an ideal kiln for cement calcination would be no more than 15 per cent., compared with the 30 to 40 per cent. consumptions which are prevalent in actual practice to-day.

Another prominent subject of investigation has been the mechanics of pulverising and grinding, and the importance of this will be realised when it is stated that, as a rule, the production of Portland cement involves reducing to powder three materials with a total weight three times that of the final product, the power so absorbed ranging from 60 to 150 h.p.-hours per ton of cement.

A feature of investigations of this nature has been the commercial scale upon which they have been undertaken, involving the presence of the research staff of engineers and chemists upon the factories of one or other of the members of the association, and this intimate connection with the practical side of the industry has been of value in preventing research becoming too academic and too far removed from practical issues.

The purely scientific side, however, has not been neglected, and in the laboratories of the association at Greenhithe researches upon the setting of cement, the influence of raw materials upon cement, and other chemical subjects are in progress, while an experimental grinding mill has also been set up in the laboratory.

The aim of the association may be briefly summarised as an attempt to cheapen the production and to improve the quality of cement, and the achievement of this aim cannot fail to benefit the consumer while tending to stabilise the British industry.

The hearty co-operation of British manufacturers in this enterprise is shown by the fact that more than 90 per cent. of their number are members of the association.

Obituary.

SIR WILLIAM ABNEY, K.C.B., F.R.S.

ANOTHER of the conspicuous leaders of British science who rendered the latter part of the nineteenth century and the commencement of the twentieth so famous as a time of remarkable progress, and whose name was almost a household word throughout the land, passed away on December 2 in the charming and unique personality of Sir William de Wiveleslie Abney. Sir William Crookes, Sir Norman Lockyer, and now Sir William Abney—the recent months have indeed been heavy with fate for that glorious band of scientific workers, and the only consolation that these severe losses in the front rank leave with us is the knowledge that their great work was done, that their last paper was written with all their full mental powers, and that they passed away, at a ripe age truly, but before any failure of their great master minds became evident to the world at large.

Sir William Abney will ever be remembered, especially under his better-known earlier designation as Capt. Abney, for four things in particular: for his great services to the nation and to the cause of science in the Department of Science and Art at South Kensington; for his researches on the infra-red of the spectrum, leading on to his masterly use of the spectrum in regard to colour vision and colour measurement; for his development of photography into an exact science; and for his studies of the forms of ice and snow in the high Alps. Those of us who had the great privilege of attending his lectures on colour and its measurement at the Royal College of Science, where for many years he was occasional lecturer in physics, will ever regard those hours as among the most delightful and thoroughly enjoyable ever spent in a lecture-room. They were brilliant, not for what was said so much as for what was done, for the experiments were ever most elegant, beautiful, and even exquisite as regards the phenomena exhibited, and marked by an originality which was the direct outcome of a most original mind. It was a still greater privilege to be able to follow him into his research laboratory, and to see something of the most fascinating experimental work going on there, with the aid of his devoted assistant, Mr. Walter Bradfield, and which at frequent intervals resulted in a paper to the Royal Society, of which Sir William was elected a fellow so early as the year 1876.

Yet perhaps the most charming side of Sir

William Abney's personality was brought out during his annual summer visits to his beloved mountains. There, among the monarch peaks, glaciers, and snowfields of the Swiss, French, and Italian Alps, he was at his best, a most delightful companion, from whom one learnt something of value almost every moment, and by association with whom one learnt to appreciate the beauty and the "call" of that magnificent world, high up above the vain ambitions and struggles of the world below, in a manner which became one of the highest experiences of one's life. For Sir William was not merely a man of science; he was also both a philosopher and an artist.

He saw and realised the beauty of the natural world as few perceive it, and he had quite a gift of expressing it in water-colours, yet was never satisfied, because he alone understood in so unique a manner how utterly inadequately the pure colours of sky and sea, landscape, and the eternal snows of the Alps can ever be imitated in pigments. And the luncheons on the ice, high up above the Alpine valleys, or the after-dinner talks when the expeditions were over, with the congenial company of distinguished climbers, such as his old friends, Mr. Horace Walker and his sister, Miss Lucy Walker, Mr. Matthews, Mrs. Jackson, Mr. Eccles, Miss Venables, and M Loppé—these are all memories of Sir William in his happiest moments, when, with Lady Abney and Miss Janet Abney, and often other members of his family, the most delightful anecdotes and stories from his immense répertoire used to delight all within earshot.

Sir William was the eldest son of Canon Abney, of Measham Hall, Leicestershire, and was born on July 24, 1843. He was educated at Rossall, and became Lieut. R.E. in 1861, and Capt. in 1873. He was president of the Royal Astronomical Society from 1893 to 1895, and of the Physical Society from 1895 to 1897. He was also chairman of the Royal Society of Arts in 1904. He was created K.C.B. in 1900, and was Hon. D.Sc. and D.C.L. of several universities. He was Principal Assistant Secretary, Board of Education, from 1899 to 1903. Besides his very numerous scientific memoirs to the Royal Society and other learned societies, he is perhaps best known for his published books, the chief of which are: "Instruction in Photography" (1870), "Treatise on Photography" (1875), "Colour Vision," "Colour Measurement and Mixture" (1893), "Thebes and its Five Great Temples" (1876), "The Pioneers of the Alps" (with C. D. Cunningham, 1888), and "Trichromatic Theory of Colour" (1914).

The moment, however, is not one for the appraisement of so full a life of scientific work, for the loss of his many-sided delightful personality is too fresh upon us. It is rather of the kindly, genial, and altogether lovable man himself that we think, and deplore the fact that nevermore shall we see his burly form and jovial face, and hear his cheery words, ever full of inspiration to all that was highest and best.

A. E. H. TUTTON.

MR. WILSON HARTNELL, who died on November 10 in his eighty-second year, was well known in connection with his work on steam-engine governors. He was elected a member of the Institution of Mechanical Engineers in 1872, and his paper on automatic expansion gears, read in 1882, has been a mine from which hosts of engineers interested in governors have extracted theorems and data of great practical value.

SIR FREDERICK TAYLOR, BT., who died on Thursday, December 2, was born in 1847, and received his medical training at Guy's Hospital. He proceeded to the degree of M.D. at London University in 1870, and was university scholar in obstetric and forensic medicine; later he represented the university on the General Medical Council. Sir Frederick was appointed consulting physician to Guy's Hospital, and remained in close touch with that institution throughout his life; he was also physician to the Seamen's Hospital, Greenwich. In 1907 he delivered the Harveian Oration. His career reached its culminating point when he was elected president of the Royal College of Physicians, and had illness not intervened he would probably have been re-elected for a second term of office. Sir Frederick was the author of numerous contributions to medical societies and journals, although he is probably best known for his "Practice of Medicine," a standard work which has reached its eleventh edition.

Notes.

IT has been generally understood that the Water Power Resources Committee of the Board of Trade has for some time been considering the possibility of tidal-power development, with special reference to the Severn estuary. In view of this it would be of interest to know to what extent the scheme formulated by the Ministry of Transport has been influenced by the conclusions of that Committee. As outlined and illustrated in the *Times* of November 26, the scheme would appear to be open to certain weighty objections, and, in view of the large number of technical problems, alike in mechanical, electrical, and hydraulic engineering, which require to be co-ordinated and solved before any such scheme can be embarked upon with any certainty of ultimate success, there would not appear to be any likelihood of its materialising immediately. At the same time the prospects of the scheme, should it prove commercially and mechanically feasible, are so great that every endeavour should be made to have the matter investigated in the fullest detail by a strong technical and scientific Commission. As pointed out in NATURE of June 3 last, much still requires to be known on such questions as those regarding the effect of the proposed barrage on the silting of the estuary and on the general *régime* of the river, the best size and form of turbine and generator, the use of alternating- or direct-current generators and of geared or ungeared turbines, the maximum economic capacity of the installation, and the volume of water actually available in the case of such an estuary as that of the Severn under operating conditions. All these are problems to which existing data are inadequate to enable a complete answer to be supplied, but to which such experience as is available, augmented by some special experimental investigations, should be adequate to give a definite answer. Tempting as the scheme may appear, it would be wise to suspend judgment as to its possibilities until the report of some such Commission as is suggested is available.

In continuation of the article in Nature of April 1 last, p. 153, on the Tropical Agricultural College in the West Indies, it may be noted that a circular letter dated January 27, 1920, was sent out by the Colonial Office to Governors of West Indian Colonies directing their attention to the report of the Committee upon the proposed agricultural college, and to the advantages that would be likely to accrue to the Colonies from its establishment. It was pointed out that the West Indies had now the chance of creating an epoch in their economic history, especially as they are at present so prosperous that they might well hope to equal or surpass any similar institution on foreign soil. Much hard work and skilled direction will, however, be necessary if Buitenzorg is to be surpassed. The letter ends by demurring to the proposal that the Imperial Government should contribute half the cost, pointing out that the Colonies do not contribute to the cost of institutions in this country that are of value to them. Later telegrams announce that the vexed question of the site has been settled in favour of Trinidad, which Colony has now a great opportunity before it. The site has been selected on the Government farm at St. Augustine, about six miles from Port of Spain. The Governments of Trinidad, Barbados, Grenada, St. Lucia, St. Vincent, the Leeward Islands, as well as Bermuda, have offered financial support.

A considerable impetus should be given to electrical research by the incorporation under the Department of Scientific and Industrial Research of the British Electrical and Allied Industries Research Association, which is the outcome of the joint activities of the Institution of Electrical Engineers and the British Electrical and Allied Manufacturers' Association. Half of a guaranteed minimum income of 16,000*l.* per annum is to be contributed by the Department of Scientific and Industrial Research, which has also undertaken to contribute pound for pound against further manufacturers' subscriptions up to twice that figure. The association is in close touch with the British Engineering Standards Association and the National Physical Laboratory, and the council, which is under the chairmanship of Mr. C. H. Wordingham, includes seven representatives each of the Institution of Electrical Engineers and of the British Electrical and Allied Manufacturers' Association, with Prof. W. H. Eccles and Sir J. E. Petavel as representing the Department of Scientific and Industrial Research. The character of the work already undertaken gives some indication of the wide field which may be covered. This includes a comprehensive investigation into composite and fibrous insulating materials, porcelain, and mica, and inquiries into particular classes of apparatus such as mining switchgear. The present programme also includes investigations on sludging in insulating oils, the preparation of data for standard specifications for these and other insulating materials, and a research on the heating of buried cables. Arrangements are in hand for rapidly extending the programme of research, and all communications regarding the association should be addressed to Mr. E. B. Wedmore, secretary and director of research, at 19 Tothill Street, Westminster, S.W.1.

The British Music Industries Research Association has been approved by the Department of Scientific and Industrial Research as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. The association may be approached through Dr. R. S. Clay, Northern Polytechnic Institute, Holloway, London, N.7.

The next meeting of the Chemical Society will be held on Thursday, December 16, at 8 p.m., in the lecture hall of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1, when Sir Robert Robertson will deliver a lecture entitled "Some Properties of Explosives."

Sir J. F. C. Snell, member of council of the Institution of Civil Engineers and past-president of the Institution of Electrical Engineers, has been appointed by an Order of Council to be a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

Prof. J. Perrin (Paris) and Prof. C. Fabry (Marseilles) have been elected honorary members of the Royal Institution, and Prof. Arthur Keith has been re-elected Fullerian professor of physiology for a further term of three years. The Christmas course of juvenile lectures this year will be delivered by Prof. J. Arthur Thomson on "The Haunts of Life," commencing on Thursday, December 30, with The School of the Open Shore as the subject, and followed by The Open Sea, The Great Deeps, The Fresh-waters, The Conquest of the Land, and The Mastery of the Air.

On December 1 the Natural History Museum Staff Association held, by permission of the Trustees, the last of its scientific reunions for the current year. Many interesting exhibits of new acquisitions to the museum collections and other specimens of exceptional interest were shown in the board room, and in a darkened room close by Dr. E. A. Cockayne gave a demonstration of the remarkable fluorescent properties of certain moths and butterflies in ultra-violet light, the specimens used being drawn from the museum collection. Among the visitors present were Lord Rothschild, Lord Sudeley, Lt.-Col. A. W. Alcock, Prof. E. B. Poulton, Prof. J. H. Ashworth, Prof. A. W. Hill, Prof. A. Dendy, Prof. J. P. Hill, Prof. E. W. MacBride, Dr. J. W. Evans, Dr. W. D. Matthew (of the American Museum of Natural History), and M. F. Le Cerf (of the Muséum de l'Histoire Naturelle, Paris).

The weather for the autumn season in the several districts of the United Kingdom is shown in the Weekly Weather Report of the Meteorological Office for the week ending November 27. The period comprises the thirteen weeks from August 29 to November 27. Temperature attained its highest reading, 76° F., in the south-east of England, and the lowest shade temperature in England was 18° F. in the south-west. The mean temperature for the period was above the normal except in the eastern districts of England and in the Midland Counties; the greatest excess was 2° in Ireland. For the whole of the British Isles the mean was 51·1°. Rainy days were fewer than the average except in the south of Ireland. The amount of rain varied from 11·34 in. for the north of Scotland to 3·77 in. for the north-east of England. The fall was less than the average except in Ireland; the greatest deficiency was 4·17 in. for the north-west of England. Bright sunshine was deficient except in England east and north-west. At Greenwich the mean temperature for the autumn was 51·2°, which is 0·5° above the mean. The mean of the day or maximum readings was 1·5° in excess of the normal; the mean of the lowest or night readings was 0·7° in defect. September had a normal temperature, October an excess of 2°, and November a deficiency of 0·5°. The rainfall for the autumn was 1·23 in. deficient. September had an excess of 1·70 in., October a deficiency of 1·54 in., and November a deficiency of 1·39 in. Remarkable as the October deficiency of rain is in 1920, the amount measured in 1919 was even less at Greenwich.

Johnson Cañon, probably the largest of the eastern tributaries of the Mancos Cañon, lies on the divide between La Plata and Montezuma Counties in Colorado. Here some important ruins are described by Mr. E. H. Morris in the thirty-third annual Report of the American Bureau of Ethnology. Large collections of interesting pottery, consisting of coil-ware ollas and some beautifully ornamented black-and-white and black-and-red bowls, have been discovered. The culture, as a whole, was a rather restricted characteristic of the Mesa Verde region, the materials for weaving, building, and pottery being procured in the immediate neighbourhood, while the fruits of wild trees and plants, as well as the cultivated crops, came, with few exceptions, from the neighbouring cañons and mesas.

The Bulletin of the New York Zoological Society (vol. xxiii., No. 4) is devoted to a survey of the history of the white rhinoceros of the Belgian Congo. The habits and external characters of this vanishing species are tersely reviewed and comparisons made with its near ally, the black rhinoceros. The traffic in the horns of this animal, it is contended, must be completely restricted if it is to be saved from speedy extinction. A number of remarkably fine illustrations add much to the value of this publication.

The Field Naturalists' Club of Victoria was founded in May forty years ago. In 1906 Mr. F. G. A. Barnard published in its organ, the *Victorian Naturalist*, a history of its first quarter of a century. In the October issue of that magazine he gives a retrospect of the last fifteen years. This vigorous society does excellent work in promoting a love of Nature and the study of natural history in the neighbourhood of Melbourne. That it succeeds in arousing the interest of the general public is shown by the fact that five exhibitions of wild flowers held during the war period for special objects brought in more than 622*l*.

Among the more important papers published in the thirty-third annual Report of the American Bureau of Ethnology is that by Mr. M. R. Gilmore on "The Uses of Plants by the Indians of the Missouri River Region." The writer remarks: "We shall make the best and most economical use of all our land when our population shall have become adjusted in habit to the natural conditions. The country cannot be wholly made over and adjusted to a people of foreign habits and tastes. There are large tracts of land in America whose bounty is wasted because the plants which grow on them are not acceptable to our people. This is not because these plants are not in themselves useful and desirable, but because their qualities are unknown. So long as the people of the country do not demand articles of food other than those to which our European ancestors were accustomed, these articles will be subject to demand in excess of production, with consequent enhancement of cost, while at the same time we have large land areas practically unproductive, because the plants they are best fitted to produce are not utilised."

The report of the council presented to the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne at the end of October records an increase of membership and a resumption of activity after the war. The museum building, of which a large part had been occupied by Armstrong College, has been overhauled, lectures and talks have been well attended, an entomological section has been established, and field excursions have been organised. Though there is nothing of particular interest to report, it is pleasing to note that the exceedingly valuable collections of the Hancock Museum have received skilled curatorial attention.

The United States Department of Agriculture has just issued Bulletin No. 794 on the waterfowl and their food-plants in the sandhill region of Nebraska, which is valuable and instructive because the resorts of these economically important birds are becoming more and more restricted owing to the draining of lakes and marshes. Hence, before it is too late, the Department has decided to take steps to conserve the remaining supply of waterfowl inhabiting these areas. This inquiry, it urges, is very necessary "if we are to take intelligently directed steps towards passing on what remains of our heritage of natural wealth." In this far-seeing policy the United

States sets an example which might well be followed by our own Ministry of Agriculture, which has frequently been urged to establish a Bureau of Ornithology for similar functions.

THE results of the inquiries made by the Special Committee on Food-grains with regard to the Indian rice industry are embodied in a report on the trade in Indian rice, to which are appended two further reports on the production and uses of rice and on the utilisation of Burmese rice and its by-products respectively ("Indian Trade Enquiry: Reports on Rice," published by John Murray). In the main report reference is made to the two branches of the world's rice trade, viz. the Far Eastern branch, requiring a cheap rice for feeding the native population, and the Western branch, requiring large quantities of a medium quality rice and smaller quantities of a high quality product. The sources of supply of these markets are referred to, and sections are devoted to the following subjects: The world's trade in rice; the rice trade of India with the British Empire and with the Continent; imports, exports, and home consumption of rice in European countries and the United States; and the comparative cost of handling, milling, and transporting rice in the United Kingdom and on the Continent. The industrial uses of rice are also dealt with, and a series of statistical tables forms an appendix to the report. In 1913 India (chiefly Burma), Siam, and Indo-China together contributed 94 per cent. of the world's exported surplus of rice (including paddy, *i.e.* unhusked rice), the amount of the Indian exports roughly equalling those from Indo-China and Siam combined. The total Indian export (2,450,000 tons) is approximately equivalent to the total requirements of the British Empire from the three chief exporting countries.

THE Cardiff Naturalists' Society has instituted a faunistic survey of Glamorgan, and as a preliminary has issued a useful pamphlet of instructions to collectors. Regional and faunistic surveys form part of the activities of many societies in Great Britain, but the work is hampered, as a rule, by the lack of concise instructions for collecting. This is a difficulty which the Cardiff Naturalists' Society has wisely foreseen and endeavoured to overcome. The pamphlet is concerned only with the terrestrial and fresh-water fauna, and each group of animals is dealt with separately and in detail. The collector is furnished with valuable hints on the habitats in which to search for special animals, and with instructions for their capture, preservation, and packing. We are glad to note the stress which is laid on the necessity for adequate data to accompany each specimen. It is a point which cannot be too often or too strongly insisted upon. The attention of workers is further directed to the advisability of collecting both the external and internal parasites of the vertebrate groups and of an examination of the stomach contents. Due regard is paid to the value of field observation in a survey such as this society contemplates, and useful advice on special points requiring further elucidation is given under each group of animals. The section devoted to insects is particularly good and full, and the collector will be specially grateful for the many hints on the manipulation of the more delicate and smaller forms. His work will be made easier for him, and the results will be more gratifying to the referees and to those who will ultimately have charge of the specimens. Altogether this is an admirable pamphlet which should be of the greatest service to those who are undertaking the field-work in connection with the survey, and should go far to ensure the success of the scheme. Other organisations contemplating similar work will find it invaluable. We understand that copies of the pamphlet may be obtained from the secretary of the Cardiff Naturalists' Society, Dr. J. J. Simpson, 35 Park Place, Cardiff, at a nominal charge of 6*d*. each, or in larger quantities at special rates if desired.

THE latest part of the Annals of the Transvaal Museum (vol. vii., part 2, 1920) contains two valuable papers by Dr. E. C. N. van Hoepen on remains of carnivorous dinosaurs from the Karroo formation of South Africa. The fossils are described in great detail, with adequate illustrations, and include all important parts of the skeleton except the skull. They seem to represent some genera allied to the European Triassic Plateosaurus, others to the North American Triassic Anchisaurus. One femur is exceptional in not being hollow. The author is to be congratulated on his painstaking work, which makes possible a more exact comparison of the South African Triassic carnivorous dinosaurs with those from other parts of the world.

DISEASES of bees known as foulbrood are dealt with by Mr. G. F. White, of the United States Department of Agriculture. In Bulletin No. 810 European foulbrood is discussed. It is an infectious disease of the brood of bees, characterised by death of the brood during its uncapped stage and by absence of odour. The stock may be weakened, or even exterminated, by the disease. In 1885 Cheshire and Cheyne ascribed the disease to a sporing bacillus, *B. alvei*. According to Mr. White, however, this organism is only a secondary invader of the dead larvæ, and not the cause. The causative organism is *B. pluton*, an ovoid and sometimes yeast-like form, which cannot be cultivated, and gains entrance to the larvæ by the mouth. American foulbrood (Bulletin No. 809) is characterised by a decided ropiness of the decaying brood and a peculiar foul odour. It is of almost world-wide distribution, and occurs in this country. The causative organism is a sporing bacillus, *B. larvae*, which can be cultivated on an agar made from bee larvæ and on an unheated egg-yolk agar. Full details respecting these diseases are given in these two bulletins.

THE latest volume (vol. xvi.) of the Special Reports on the Mineral Resources of Great Britain, issued by the Geological Survey, contains an account of the petrography and chemistry of the refractory materials, ganister, silica-rock, sand and dolomite, by Messrs. H. H. Thomas, A. F. Hallimond, and E. G. Radley. It may be looked upon as a continuation of vol. vi.

of the same series, which dealt with the geology and mode of occurrence of these materials, and thus completes the information on these important substances already published. The chemistry of the raw materials and the chemical changes which they undergo in order to fit them for use in the furnace are discussed in some detail, and a number of complete analyses, most of which have been made in the Survey laboratory, are included. Much attention has also been devoted to the microscopic examination of the materials in their native state, as prepared for use in the furnace and after such use. The volume is, therefore, likely to be found extremely valuable to all users of refractory materials, more particularly to steel-makers, whose requirements have evidently received special attention.

THE process of cold vulcanisation of rubber invented by Mr. S. J. Peachey, to which reference was made in NATURE of July 15, p. 625, consists in treating the rubber alternately with sulphur dioxide and hydrogen sulphide. The gases are separately absorbed by the rubber, and by interaction produce a highly active form of sulphur which brings about vulcanisation. The process obviates the use of sulphur chloride, and, since it takes place in the cold, renders possible the use of organic filling and colouring agents which are not affected by the two gases, but would be decomposed in the ordinary process.

AN excellent feature of a new catalogue received from Mr. Cuthbert Andrews (47 Red Lion Street, W.C.1) is a series of six coloured plates illustrating X-ray tubes in action. These illustrations, besides being extremely good technical productions, should be very instructive to those who desire to familiarise themselves with the various appearances of X-ray tubes. There is, of course, still a wide field of utility in the gas-tube, and the various devices designed to overcome some of their vagaries are dealt with in detail in this catalogue. Protective measures in X-ray work are not lost sight of; the appliances manufactured by Mr. Andrews are given the rather happy name of "Protex."

THE difficulty experienced by workers in damp climates in maintaining the insulation of electrostatic measuring instruments has, according to the July issue of the Journal of the Asiatic Society of Bengal, led Prof. Jackson and Mr. A. T. Mukerjee to enclose their Dolezalek electrometers in hermetically sealed cases and to test the efficiencies of the desiccators in common use. They find that for reducing the rate of leak from such an electrometer calcium chloride, sodium, quicklime, and phosphorus pentoxide are valueless, owing possibly to the chemical action between them and the moisture they take up producing ions which render the air conducting. Sulphuric acid boiled with a small quantity of ammonium sulphate, as recommended for Kelvin electrometers, and having a density of 1·84, corresponding to 95 per cent. of pure acid, is the only desiccant they have found to be entirely suitable. If occasionally stirred it retains its efficiency for several weeks.

THE October issue of the Journal of the Franklin Institute contains the address on optical glass given by Dr. A. L. Day, the director of the geophysical laboratory of the Carnegie Institution, and during the war in charge of optical glass production, to the physics and chemistry section of the institute in March last. In the course of the address Dr. Day described the steps taken by the United States Government to help the manufacturers to overcome the difficulties of the manufacture of optical glass in sufficient quantities to meet the demand produced by the war. It was found that the manufacture was not beset with mysteries as it had been represented to be, but that it was a straightforward scientific problem solvable by the methods commonly used in attacking problems of high precision. The results of the experience are all published, and are available for those who wish to make the manufacture of optical glass a permanent industry of the country. It is, however, recognised that the demand will be small, and that the industry may have to be subsidised by the Government, or, if not, to depend on other lines for its profits.

MESSRS. PASTORELLI AND RAPKIN, LTD., of 46 Hatton Garden, London, E.C.1, have forwarded to us their list of self-recording meteorological instruments. The various forms of barographs afford ample choice to satisfy the different uses for which these instruments are required. The "dial barograph," which gives the face of the ordinary aneroid as well as the charted record, adds much to the interest of the reading of atmospheric pressure. With the new units of measurement which are now becoming of such general use it seems desirable that the scale should be given in millibars as well as in inches. Barothermographs showing the records of pressure and temperature on the same drum will be welcomed by many. The Edney hygrograph seems an improvement on the ordinary arrangement for securing an accurate temperature and for reducing the sluggishness introduced into some other forms of thermographs. Prices are necessarily high in comparison with pre-war rates, but the advance is not excessive. The firm has a long record, since 1750, which is essentially an advantage to a maker of all kinds of scientific instruments, as many improvements are the more easily recognised.

THE presidential address of Mr. Ll. B. Atkinson to the Institution of Electrical Engineers, delivered on November 18, marked the commencement of the jubilee year of the institution, which was founded in 1871 as the Society of Telegraph Engineers, although a previous society, called the Electrical Society of London, had existed from 1837 to 1845. In reviewing the progress achieved during the last half-century the president traced the changes in our conceptions of electrical and other physical phenomena from Maxwell's original ideas to the modern electron theory and the newer outlook revealed by the researches of Einstein and others. The development of methods of generation of electrical currents by mechanical means was followed from the discovery of the self-exciting dynamo in 1867 to the large turbo-alternators of to-day. Mr. Atkinson looked forward to further progress in the gas turbine, and hinted that some process of current production avoiding the limits imposed by the second law of thermodynamics might be found, and that perhaps an electrical method of unlocking the stores of energy in the atom might ultimately be discovered. After a few words on the history of electric supply, transmission of power, and cable manufacture, Mr. Atkinson passed on to a review of telegraph and telephone progress. Both submarine and land line telegraphy had reached a high degree of advancement when the institution was founded, but the telephone did not exist, and such ideas as there were on the possibility of communication without wires were in the direction of earth conduction. Recent developments included applications of the wonderful thermionic amplifier to cable telegraphy as well as to line telegraphy and wireless. Among matters requiring further research were the development of more exact methods of estimating the quality of transmitted speech and multiplex and superposed telephony.

Messrs. W. Heffer and Sons, Ltd., Cambridge, have just issued a catalogue (No. 194) of publishers' remainders which should be seen by those on the look-out for standard books in a new condition as Christmas or New Year presents. Many of the volumes offered for sale deal with scientific subjects, but most are of general interest. All are listed at prices far below those at which they were published. The catalogue is obtainable upon application.

Our Astronomical Column.

The December Meteors.—These meteors are due to reappear on the nights of December 10–13, and with suitable weather ought to be well observed this year, as there will be no interference from moonlight. The maximum will probably occur on December 12, when the radiant will be at $112° + 33°$ near α Geminorum. The point of radiation apparently moves eastward at the rate of 1° daily. The meteors are moderately swift, sometimes slow, but their individual aspects depend in a measure upon their relative positions with respect to the observer and the radiant. In the early hours of the evening the flights are longer than in the later part of the night, the radiant being higher in the sky in the small hours of the morning.

Minor Planets.—Ceres will be in opposition on Christmas Day in high north declination, its magnitude being 7·2. The following approximate ephemeris for Greenwich midnight is from Marseilles Circular No. 412:

	R.A. h. m. s.	N. Decl. ° ′		R.A. h. m. s.	N. Decl. ° ′
Dec. 3	6 37 48	25 27	Dec. 18	6 24 30	26 41
8	6 33 54	25 52	23	6 19 24	27 5
13	6 29 24	26 17	28	6 14 6	27 27

Log r, log Δ December 3, 0·424, 0·240; December 23, 0·421, 0·219.

The planet is close to ε Geminorum at the beginning of December.

Astr. Nach. Circular No. 46 reports the discovery of a very interesting planet which has been provisionally named HZ. It was found photographically by Dr. W. Baade at Bergedorf on October 31, and observed again on November 2 and 12, its magnitude being about 13. Dr. G. Stracke has computed the following elements:

Epoch 1920 *October* 31·5 *G.M.T.*

M = 348° 33′ 35·4″	μ = 320·085″
ω = 57 38 40·2	log a = 0·696494
☊ = 21 22 26·8	log q = 0·2887
i = 41 28 58·6	T = 1921 March 9·2
φ = 37 31 0·8	Equinox 1920·0

It will be observed that the value of the mean motion would make it a member of the Trojan group, but the very large inclination and eccentricity (which are cometary rather than planetary) would prevent any close adherence to the equilateral configuration with the sun and Jupiter, which is the characteristic of that group.

Ephemeris for Greenwich Midnight.

	R.A. h. m. s.	N. Decl. ° ′
December 6 ...	0 8 16	18 27
10 ...	0 7 24	19 18

The perihelion and aphelion distances are 1·944 and 7·998 respectively.

Photographic Parallax Determinations at Allegheny.—Vols. iv. and v. of the Publications of this observatory, of which Prof. F. Schlesinger is director, contain parallaxes of nearly three hundred stars, the average probable error being given as 0·008″. A few of the larger parallaxes are recorded below, with notes on previous determinations. An asterisk denotes a spectroscopic parallax:

Star	Parallax ″	Some previous determinations in ″
τ Cygni ...	0·058	0·125, 0·029, 0·006, 0·023
ι Pegasi ...	0·067	0·063, 0·120
μ „ ...	0·043	
β Virginis ...	0·096	0·110, 0·100*, 0·096
42 Coronæ ...	0·064	0·119, 0·058
ζ Herculis ...	0·114	0·172, 0·101, 0·146, 0·086, 0·066*
μ „ ...	0·104	0·122, 0·126, 0·093, 0·051, 0·096*
85 Pegasi ...	0·084	0·054, 0·096, 0·084, 0·101, 0·096*
{OΣ 547 (mean)	0·103	0·134, 0·095, 0·120*
{Furuhjelm star[1]	0·099	0·112
χ Orionis ...	0·096	
8 Canum Ven.	0·109	0·089, 0·084, 0·105*
ξ Boötis ...	0·147	0·225, 0·151*
η Cassiopeiæ...	0·173	0·188, 0·182, 0·178*, 0·180
61 Cygni (mean)	0·285	0·270, 0·272, 0·322, 0·301
Castor (mean)	0·070	0·053

[1] This star has the same P.M. as OΣ 547, being 5½′ distant.

The great advance in the accuracy of photographic parallaxes in recent years is very satisfactory. It may be ascribed to the many additional precautions now taken, notably the equalisation of magnitudes by rotating sector or otherwise, and confining the photographs to the neighbourhood of the meridian to minimise the effect of atmospheric dispersion.

Vol. vi., No. 2, of the Allegheny Publications contains a paper by Mr. C. J. Hudson on the amount of error arising from this dispersion. The effect on pairs of plates taken at considerable hour-angles east and west is 0·021″. It should be quite negligible on the parallax plates.

Migrations of Cultures in British New Guinea.

THE HUXLEY MEMORIAL LECTURE FOR 1920.

THE Huxley memorial lecture of the Royal Anthropological Institute was delivered by Dr. A. C. Haddon at the rooms of the Royal Society on November 23.

In opening his address Dr. Haddon suggested that the immediate cause of the interest taken by Huxley in anthropology may have been the memorable voyage which he made more than seventy years ago in the *Rattlesnake* when he was sent out to survey the marine zoology of the Torres Straits and various parts of the coast of New Guinea. He himself had been first attracted to anthropology when in 1888 he visited the Torres Straits, also with the object of studying marine zoology. It was therefore, in his opinion, not inappropriate that it had fallen to his lot to pay homage to the memory of a master of scientific method and of clear exposition, and that he should select the area of their respective first experiences in travel for the subject of his discourse.

On the coast of British New Guinea is found a series of cultures, some of which are evidently related, others as obviously unrelated. Their affinity suggests a common origin, but any idea of indigenous development or of cultural migration from Australia may at once be dismissed.

The cultural problems of the south-eastern peninsula and of the outlying islands of New Guinea are, in the main, quite distinct from those to the west, and the differences between the two groups of cultures indicate clearly that there cannot have been any extensive cultural movements from the Papuo-Melanesians of the east to the western Papuans. We are thus driven, on general grounds, to the supposition that the cultures of the southern coast of British New Guinea came down more or less from the north.

The Tugeri, who live just beyond the Netherlands border, are cannibals and inveterate head-hunters who chew kava, *vati*. The inhabitants of several villages assemble at initiation ceremonies, at which bullroarers are swung, but the bullroarer is not known elsewhere in Netherlands New Guinea. There are many dances at which masks are worn and animals represented. The bullroarer is anthropomorphised as Sosom, a mythical monster of the bush, who at the annual festival at the beginning of the south-east monsoon devours the novices, but brings them back to life. There is such a striking resemblance between this complex and that of various tribes in the area from Astrolabe Bay to Huon Gulf that a relationship cannot be denied.

The use of kava has such ethnological interest that it is worth while noting its distribution in New Guinea. Several of the bush tribes west of the Fly estuary chew kava. Effigies of crocodiles are presented with kava by the Masingara, and a legend suggests a former monster who ate novices at the initiation ceremony. Kava plays an important part in the several ceremonies of the Kiwai peoples, and only those who have passed through all the stages of initiation may drink it. The Gogodara, who live between the Fly estuary and the Bamu, have an initiation ceremony in which a boy is supposed to be eaten by a crocodile, and kava is drunk. The tribes to the north of Huon Gulf hold a periodic circumcision ceremony at which, to the humming of bullroarers, the initiates are dragged into a hut constructed like a monster, which thus symbolically swallows them. An important part of the initiation ceremonies consists in teaching the novices how to play the sacred flutes.

To return to the south coast. The Kerewa folk live in Goaribari Island and its neighbourhood. They have carved shrines to which skulls of people who have been eaten are attached. Further east are the Namau group. Here are enormous ceremonial houses with numerous shrines, associated with a *manes* cult, in front of which are heaps of animal, and formerly of human, skulls. In the dim recess of the building are basketwork monsters. The Elema or Gulf culture, further east, is essentially similar, except that the monsters are lacking and the people are not cannibals.

The Great Sepik River possesses several cultures along its course, one of which is characterised by so many general similarities with the cultures of the south coast that there must have been some connection between them; for example, there are numerous plaitwork masks which find an exact counterpart in the Middle Fly, on the Bamu, and in the Kerewa country. The great difficulty alike in the supposed spread of kava-drinking from the Huon Gulf-Astrolabe Bay area to the mouth of the Fly and beyond, and in the extension of the Sepik culture to the south coast, is the great mountain chain of New Guinea. It would be easier to suppose that these cultures, which, so far as is known at present, are discontinuous, were carried to their respective areas by seafaring people, but no traces of similar cultures are found in the intervening coastal areas; furthermore, the western canoes (except in the Torres Straits area) are a river type, and can be matched from the Sepik. An interesting problem is that of the woven rattan cuirasses; these occur on the north coast at the Netherlands boundary and some way to the east of it, also some distance inland south of this area, and again on the Palmer River and Upper Fly, and, finally, a feebler type is found in the mountains up the Utakwa River in Netherlands New Guinea. It is inconceivable that a migration could have carried this armour all round New Guinea and right up the Fly without leaving traces *en route*. The most rational view is that it has spread down from the north coast, in which case it would have crossed the mountain chain, as the Sepik cultures are assumed to have done.

The south-eastern peninsula of New Guinea is characterised by the absence of the features of the western cultures and the presence of a big feast, with which in the region round Milne Bay is associated the cult of the mango-tree. In the Mambare and Kumusi river-systems initiation ceremonies are again met with, the bullroarer is employed, and a pair of sacred flutes played. The use of the sacred flutes links up with the initiation ceremonies of the peoples to the north of Huon Gulf, and their use extends all along the coastal peoples well into Netherlands territory, as well as up the Sepik. It seems as if the use of the flutes tended to supplant that of the bullroarer. The distribution of the flutes further coincides fairly closely with the employment of slit gongs. Both these instruments appear to belong to a relatively recent cultural movement from northern Melanesia.

From this it will be evident that the ethnological history of New Guinea is extremely complex; movements have taken place within the island, and cultural influences have come in from without. The south-eastern peninsula has been the scene of two different migrations, resulting in the Motu and Massim cultures, and probably a third one influenced the Trobriands. These were perfectly distinct from the probable migrations from northern Melanesia which have modified the northern coastal cultures. These have come on the top of Papuan cultures, the more striking features of which have probably been due to earlier cultural drifts from Indonesia. At present it is only possible to state some of the problems and to hazard conjectures as to their solution. Very much work remains to be done before the history of this fascinating island can be unravelled.

At the conclusion of the address the Huxley memorial medal was presented to the lecturer by Sir Everard im Thurn, the president of the Royal Anthropological Institute.

International Weather Telegraphy.

THE International Commission for Weather Telegraphy, appointed at the general Meteorological Conference at Paris in October, 1919, met at the Air Ministry during the week November 22–27. The delegates were welcomed at the first meeting on Monday, November 22, by Major-Gen. Sir F. H. Sykes, Controller-General of Civil Aviation, who emphasised the special need for international agreement in meteorology because nations were more interdependent in respect of that science than of any other.

During the meeting the Commission came to an agreement upon the codes for the transmission of surface observations and upper-air observations in land messages and for a new figure code for the transmission of reports from ships at sea.

It also agreed upon a time-table for the issue by radio-telegraphy of data messages for the preparation of synoptic charts and upon the distribution of stations in Europe for the issue from the Eiffel Tower of collective data messages for the whole European *réseau*.

The principal changes in the new code are:

(*a*) The number of figures for reporting barometric tendency is reduced from two to one, and the unit for barometric tendency is standardised as the half-millibar per three hours, or, for countries using the millimetre scale, the half-millimetre per three hours.

(*b*) A two-figure code for reporting the weather takes the place of the old single-figure code, and permits the intensity and character of the precipitation to be reported.

(*c*) Provision is made for reporting visibility up to 30 km. according to a graduated scale.

(*d*) One figure is allotted to reports of humidity which will be given to the nearest 10 per cent.

Prior to 1911 the code for international messages provided for reports of the temperature of the wet bulb as well as of that of the dry bulb. The temperature of the wet bulb was omitted after the introduction of barometric tendency, and thereafter no information about humidity was included in the messages. The new conditions, which permit of the international exchange of the full report for 1 p.m. and 6 p.m., and for the inclusion of humidity in the upper air for reports of surface humidity, should prove of considerable value.

(*e*) One five-figure group is allotted to reports of the form, amount, and height above ground of the clouds. It may be noted that the height of the clouds above ground and the visibility are at present the two elements of the greatest importance to aviation.

(*f*) Provision is made for reporting twice a day the hour of commencement of rainfall. This has been proved to be of great value by actual trial in Scandinavia, and it is anticipated that it will ultimately be one of the most important data in the preparation of forecasts for agriculture.

(*g*) A special group of five figures is allotted to a selection of stations in each country for the purpose of reporting as exactly as possible the direction and relative speed obtained by nephoscopic observations of clouds.

(*h*) Three special groups are allotted to selected stations in each country for reporting the direction and speed of the upper wind as determined by observations with pilot-balloons, shell-bursts, kite-balloons, and other methods.

(*i*) Ten groups as a maximum have been allotted to one, two, or three stations in each country where facilities are available for obtaining the temperature and humidity of the upper air to great altitudes by means of aeroplanes or kite-balloons.

In connection with the observations of the upper air, the Commission was interested to learn from Prof. de Quervain of the proposal to establish a station in Switzerland at an altitude of 3500 metres, from which barometric observations would be of the highest value in the construction of charts for that level.

The code adopted for the reports by wireless telegraphy from ships at sea provides for the same information as that which is given in the messages on land with the omission of barometric tendency, relative humidity, and the height of clouds. A new feature is the introduction of the method of checking the reports already used in the Meteorological Service of India. The necessity for some system of this kind was emphasised at the Meteorological Conference at Innsbruck in 1905 during a discussion on the possibility of obtaining wireless messages from the Atlantic. The new code provides a simple and practical method for discovering any error which exists and for correcting it.

The Commission learned with much interest that meteorological observations were being made this winter on behalf of the Norwegian Institute in the Island of Jan Mayen, which is situated about 600 miles north-east of Iceland; and that there was a prospect in the not distant future of obtaining meteorological observations from Greenland by radio-telegraphy.

The hard work of the business meetings of the Commission was relieved by a number of social gatherings. On November 22 Sir Napier and Lady Shaw gave a reception to the delegates at 10 Moreton Gardens, S.W. On the afternoon of November 24 a visit was paid by the delegates to Croydon Aerodrome, and an opportunity afforded them of seeing the meteorological and wireless arrangements necessary at the terminus of air routes. On November 25 the delegates were entertained to luncheon at the Carlton Hotel by his Majesty's Government, when the Marquess of Londonderry, Under-Secretary of State for Air, referred in a characteristic speech to the achievements of the delegates, some of whom had come from countries so widely separated, both by distance and by climate, as Java and Iceland. On the evening of November 26 the Maharaj Rana of Jhalawar gave a dinner in honour of the delegates; they were one and all delighted with the informal hospitality of his Highness, who had assisted at the last meeting of the Commission in 1912 and had maintained his interest in meteorology, especially British meteorology, which had made notable advances under the direction of Sir Napier Shaw, the president of the International Meteorological Committee.

Zoology at the British Association.

THE meetings of Section D attracted a large gathering of zoologists from this country and a worthy representation from the Dominions and from the United States. Prof. Gilson, of Louvain, was the only Continental guest of the Section.

Discussions.

The discussion on the need for the scientific investigation of the ocean has already been reported in NATURE of September 2 (p. 30), and Mr. H. G. Maurice's address in which he urged that fisheries research is the business of the State was published in NATURE of November 25. The discussion on this address may now be briefly summarised.

Prof. James Johnstone entirely agreed with Mr. Maurice that a Government Department of Fisheries ought to be thoroughly staffed and equipped for the prosecution of scientific research. But this policy brought a serious responsibility, for sooner or later the fishing industries would ask for the results of the investigations, *e.g.* whether fish had become more abundant or whether investigation had suggested new and improved methods of utilising sea-fish and products at present useless. As a practical suggestion he thought that in all such economic scientific investigations a new kind of worker was now necessary—the man of the inventor type of mentality—whose task it would be to apply to industry the new discoveries of the laboratory, marine station, or exploring vessel. Pure scientific investigation for its own sake was the proper work of the universities and marine stations, and no development of economic research ought to curtail it.

Prof. Gilson (delegate of Belgium on the International Council) supported the view that a maritime country should have a Department of Fisheries Research, and stated that Belgium has adopted this system and, notwithstanding the profound disorganisation of her finances, granted the sum asked to enable her full share of oceanographical and fisheries research to be undertaken.

Prof. Garstang remarked that twenty years ago they were in the midst of acute controversies between rival groups of marine biologists and between all these and the Fisheries Department in regard to the initiation of the International North Sea Investigations. It was, therefore, particularly gratifying to him to note the unanimity which now prevailed as to the wisdom of the arguments which induced the Government to proceed with that enterprise and were now put forward by the Ministry of Fisheries as convincing reasons for its continuance. It must, however, be recognised that there is a danger to science of its best exponents in one subject being concentrated into one Government Department.

Prof. Meek said that all were of the same mind that a Government Department should be fully equipped for research so long as the independence of pure science was maintained and it was recognised that much of the work could be done in independent institutions. He then went on to refer to recent trawling results on the Northumberland coast, which showed that fishery conditions in those waters were the same to-day as in 1913. He referred to the areas of distribution of fish from the Canaries to Barents Sea, and pointed out that explanations must be sought in the study of movements of water and of the lives of diatoms and other microscopic organisms.

Mr. Neale (Cardiff) stated that neither the Government nor practical fishermen have given enough consideration to the future of fisheries. He found the catches to be no larger now than before the war, and in some cases they were smaller, and he was inclined to believe that natural causes were mainly contributory, and that knowledge of these was required. The amount of ocean fished is very small as compared with the total area of the ocean, and he asked for investigations which owners of commercial trawlers could not carry out.

Dr. E. J. Allen expressed satisfaction with the broad views on scientific research now held at the Ministry of Agriculture and Fisheries and put forward by Mr. Maurice, and remarked that it was also gratifying to hear that those engaged in the fishing industry now realised the usefulness of scientific investigations.

Mr. Maurice briefly replied, explaining that collaboration in fisheries research was on the high road to being achieved between England, Scotland, and Ireland, the three countries settling their schemes and policy by quarterly inter-Departmental conferences.

The president (Prof. Stanley Gardiner) suggested that the Section might arrange for a full day of discussion at its meeting in Edinburgh in 1921, and circularise the various fishery federations and associations to see if their members would be inclined to attend the meeting of the Association and put up their own facts and problems for friendly discussion with the scientific members of the Association. The position of the Scottish capital as a common meeting-ground for the four greatest trawler ports—Aberdeen, Fleetwood, Grimsby, and Hull—seemed to him to offer an eminently favourable opportunity for such discussion.

Protozoa.

Prof. C. A. Kofoid described recent observations by himself and his pupils on the neuro-motor system of ciliate and flagellate protozoa. The perfection of the Barber micro-dissection apparatus, which can be operated with great delicacy of action under an oil-immersion objective, has made possible the demonstration of the existence in certain protozoa of a complicated fibrillar system comparable with the nervous and muscular systems of higher animals. This integrated neuro-motor system is connected with the nucleus, and plays an important part in the division of the organism into two. Experimental proof of the conducting function of the fibrillar system in the ciliate Euplotes was established recently by Dr. Taylor, who succeeded in cutting the fibrils in the living animal. He observed that in these cases there was interference with the integrated co-ordinated movements of the animal. Cuts of similar extent made in other specimens, but which did not sever the fibrils, did not produce interference with co-ordination.

Prof. Kofoid pointed out that many of the flagellates are asymmetrical, and generally have a sinistral or left-handed torsion. The origin of bilateral symmetry which prevails in Metazoa, composed of many cells, appeared to him to be bound up with two features of the structure of protozoa: (1) The co-ordinating mechanism, already referred to, in the protozoa and its persistence in the form of fibrils connecting the constituent cells of the Metazoa; and (2) the production during division into two of a sinistral and a dextral daughter-cell, the latter due to a reversal of the primitive sinistral symmetry and forming a mirror-image of the left one, the maintenance of the union of these two cells thus providing the first step in the origin of primitive bilateral animals.

Prof. R. W. Hegner discussed the relations of nucleus, cytoplasm, and external heritable characters in the genus Arcella, in which the nuclei can be seen and measured in the living animal and the chromatin mass accurately determined. Pure lines of *Arcella dentata*, obtained during vegetative reproduction from "wild" specimens by pedigree breeding methods, differed from one another in size and spine-number, which are closely correlated—the larger the shell, the greater the number of spines. These two characters were found to be correlated also with chromatin mass, for uninucleate descendants of halves (obtained by cutting into two) of binucleate animals were only about half as large as binucleate specimens belonging to the same line. The uninucleate descendants of halves of binucleate specimens always regained the binucleate condition after a few generations. The later descendants were always binucleate, but the size and spine-number of the typical binucleate were reached only after three or four more generations, during which the diameter of the shell and the number of spines increased gradually, *i.e.* the great change within—the doubling of the chromatin mass—was accompanied externally by small changes in a definite direction. If the internal condition had not been known, the conclusion would have been reached that the change in external heritable characters was due to several gradual modifications instead of to one large mutation.

Messrs. E. Heron Allen and A. Earland read a paper on protoplasm and pseudopodia, based on observations on Foraminifera. They conclude that protoplasm is capable of almost unlimited extensibility and attenuation by imbibition of water, and that pseudopodia are not extended as such, but formed from protoplasm surrounding the shell. They claim for the pseudopodia a rudimentary nervous reaction to stimuli.

Prof. Kofoid exhibited a series of plates for a forthcoming monograph on the unarmoured Dinoflagellata, and Miss C. Herdman exhibited living specimens of Amphidinium from Port Erin.

The Influence of Salts on Growth.

Dr. Cresswell Shearer read a paper on the influence of salts on growth. He described experiments which show that living bacteria offer considerable resistance to the passage of ions of various salts; dead bacterial protoplasm offers no resistance. There is something peculiar to the living state that conditions this resistance, and this should be kept in mind in all applications of the results of protein chemistry to living protoplasm.

Annelids.

In a communication on the polyphyletic origin of genera in the Oligochæta and its bearings, Prof. J. Stephenson showed that the genera of the Megascolecidæ can be arranged in the form of a phylogenetic tree. The differentiating characters are few, *e.g.* in the majority of genera of the sub-family Megascolecinæ they concern only the setæ, prostates, and nephridia. The evolutionary changes in these systems have demonstrably taken place more than once, and the differentiating characters and their various combinations are few enough to render it probable that the same combination, *i.e.* the same genus, has been reached in more than one way. Apart from probability, there is anatomical and geographical evidence that the genus Megascolex has arisen from both Notoscolex and Perionyx, and from Notoscolex more than once. The multiple origin of Microscolex from Notiodrilus has also been demonstrated, and there is some evidence of the multiple origin of Pontodrilus. To assert the polyphyletic origin of a genus is, however, unorthodox; writers obviate it by merging the genera concerned, but this is to evade the difficulty. The answer given to the question of polyphyly has a bearing on geographical distribution. A number of genera of the sub-family Megascolecinæ occur both in India and Australia; the Octochætinæ occur only in India and New Zealand. These distributions are explained by assuming land-bridges between India and Australia and between India and New Zealand. But such connections cannot have existed since the Eocene, or Eutherian mammals would have entered Australia and New Zealand. Earthworms are, however, a recent group, and such a genus as Megascolex is among the phylogenetically youngest earthworms; its origin, and probably that of other genera common to the two regions, must have been recent (since the Eocene). Land connections are thus apparently insufficient to explain the distribution, and a double origin of at least the phyletically younger genera seems worthy of consideration.

Prof. Pierre Fauvel sent a summary of the results of his examination of the marine annelids collected in the Abrolhos Islands by Prof. Dakin. Sand- and mud-dwelling Polychæta were absent; Aphroditidæ and Eunicidæ were plentiful, together with Amphinomidæ and a few Nereidæ—a small fauna of Polychæta creeping on the stones and corals. Of the nineteen species from the Abrolhos, five are known only from the warmer parts of the Indian Ocean, eleven belong to the tropical area, but often extend beyond it northwards and southwards, and three belong to the Australian coast. The Polychæt fauna of the Abrolhos is probably the same as that of most of the coral-reefs of the Indian Ocean, with the addition of a few species belonging to the Australian coast.

Hookworm and Human Efficiency.

Prof. Kofoid, in an address on hookworm and human efficiency, described investigations made in the United States Army in connection with the elimination of hookworm infection among recruits. Examination revealed an infection of about 10 per cent. among men from the Southern States, and a slightly higher rate among whites than among blacks. A statistical investigation of the incidence of disease among 24,000 men at Camp Bowis, Texas, over a period of eight months (including that of the measles-pneumonia epidemic of the winter of 1917–18) showed that men in whom hookworm infection had been detected had a much higher sick-rate, and were more often sent to hospital for severe infections. Regiments with more than 10 per cent. infection by hookworm had a much higher death-rate from pneumonia than regiments with less than 10 per cent. infection by the worm. A comparison of the mental ratings obtained by the tests of the Psychology Board of the U.S. Army in the case of 10,000 recruits from the hookworm area showed that white able-bodied men with hookworm infection have a lower average rating than men in whom the infection was not detected. The mental deficiency thus measured was nearly 25 per cent., and affected all grades of intelligence from the highest to the lowest, but the latter somewhat more severely. Hookworm infection, even in cases when it is light, is a matter of great educational, sanitary, and economic importance.

Physiology of Migration.

Prof. A. Meek discussed the physiology of migration. He stated that the passive denatation of the egg, larval, and young stages of fish may be, and usually is, succeeded by an active down-current migration which is accompanied by seasonal on-shore and off-shore movements. But the periodic migrations of the species are markedly interrupted when the call of maturity comes. Then the migration is contranatant, a longer or shorter distance according to species and circumstances, due to the effects of an internal secretion or hormone which exercises a profound influence on the central nervous system, and may also produce somatogenic results. The only invertebrate which is definitely known to react in this way on the approach of spawning is the crab—the females migrate contranatantly at that period—but it may be presumed that other large, active Crustacea and Cephalopoda respond similarly. Prof. Meek referred to Amphibia as being similarly affected at the spawning season, the hormone bringing about a return to gregariousness as well as somatogenetic effects which characterised the period. The same appears to be true of aquatic reptiles, birds, and mammals, and Prof. Meek suggested that this pointed a way of approach to the subject of aerial migration. In the discussion following, Prof. Lloyd Morgan directed attention to the breeding habits of lapwings, and suggested that they were to be explained as due to hormone action, and other speakers proposed that attempts should be made to isolate and experiment with the hormone. Prof. Garstang discussed the question with reference to plaice, and Prof. Meek replied, pointing out in this case the distinction between the periodical and the spawning migrations.

Embryological Studies.

Prof. J. E. Duerden gave an account of the pineal eye of the ostrich (for a summary of this paper see NATURE, vol. cv., pp. 516–17), described a caudal vesicle in ostrich embryos, and recorded the presence of Reissner's fibre. In embryos of about ten days' incubation a prominent vesicular swelling is present at the tip of the tail or on the dorsal surface near the tip. The cavity of the vesicle, in which the central canal of the spinal cord terminates, varies much in size and shape in different specimens. The ventral wall of the spinal cord lines the floor of the cavity and terminates somewhat abruptly, and the dorsal wall of the cord merges gradually into the mesenchymal tissue which constitutes the dorsal and lateral walls of the vesicle, without, however, showing any differentiation into an epithelial layer. The cavity is filled with a coagulable fluid in which cellular tissue in process of degeneration frequently occurs, and occasionally much black pigment is present. The external enlargement persists for only a short time, rarely lasting after the twentieth day of incubation. A similar vesicle has been found in several reptiles, and is well-developed in the penguin and the puffin, though in these it is not so large as in the ostrich. It is suggested that the vesicle in the ostrich, which varies so much in size, is in some way concerned with the regulation of pressure of the cerebro-spinal fluid at this early stage. Longitudinal sections of the caudal region show the presence of Reissner's fibre and its posterior attachment to the mesenchymal tissue. Reissner's fibre has been found to occur within the central canal of the spinal cord of vertebrates from the cyclostomes to the primates.

Mr. J. H. Lloyd dealt with the early development of the pronephros in Scyllium and Chrysemys, and supported Mr. Burlend's view that the pronephros arises as a non-segmental groove from the somatic layer of the mesoblast, and that the anterior portion of the duct is formed by constriction from this groove, and not by fusion of the distal ends of tubules. The evidence, as presented by the illustrations, was not convincing, and was subjected to considerable criticism.

The Movements of the Sea.

At a joint meeting of Sections D and E, Dr. E. C. Jee gave a paper on the movements of the sea. He pointed out that the temperature of the deep waters surrounding the British Isles is essentially due to the Atlantic circulation. He dealt in some detail with the northern North Sea current, and stated that no significant correlation has yet been demonstrated between the variations of this current and fluctuations in the landings of fish. The current which enters the English Channel from the Atlantic affects the fisheries of the south-west area, and its strength seems to show the following variations: A winter maximum and a summer minimum, and a two-year, a six-year, and a twelve-year periodicity. It is probable that the fluctuations in the landings of pilchards are correlated with the variations in strength of the Channel current. The periodicities referred to are now being investigated by the International Council. The examination of numerous samples of sea-water and the liberation of surface and bottom drift-bottles are being undertaken with the object of obtaining information for a study of the migrations of mature plaice to and from their spawning-grounds in the Flemish Bight and the probable drift of the pelagic plaice eggs and the location of the fry in their various stages of development.

Prof. E. B. Poulton gave a preliminary account of the hereditary transmission of a minute, extremely variable, and generally asymmetrical marking in the forewing of the currant moth (*Abraxas grossulariata*).

J. H. ASHWORTH.

University and Educational Intelligence.

BIRMINGHAM.—At the last meeting of the council the Principal reported that the Staffordshire Education Committee is increasing its grant to the University from 450*l*. to 1000*l*. per annum. The Worcestershire County Council recently increased its annual contribution from 300*l*. to 500*l*.; and the Dudley Town Council has informed the University that it will include an annual sum of 50*l*. in its estimates.

Messrs. Dorman and Co., of Stafford, have presented a 20-h.p. petrol engine, and Messrs. Sturge and Co. an old beam engine. The Pro-Vice-Chancellor, Alderman Clayton, is providing 100*l*. towards the cost of removal and re-erection of the latter.

The University is affording facilities in the department of pathology to enable Prof. Shaw Dunn to take part in the training of the Naval and R.A.M.C. *personnel* required for the physiological department of the Chemical Warfare Section at Porton.

Mr. R. W. W. Sanderson has been appointed a demonstrator in physics for the current session.

Mr. R. G. Abrahams has been appointed honorary assistant curator of the pathological museum, Section of Surgery.

CAMBRIDGE.—By the time that this issue appears the vote on the admission of women to membership of the University will have taken place. Both sides are hopeful of the issue, and a fairly close vote is generally anticipated. Something of the vigour of the earlier fighting on this question has vanished, perhaps because the "old guard" realise that they are fighting a losing battle. If they hold their privileged position this time they know that their flanks are in the air, and that it is only a short time before they are liable to be overwhelmed in an attack from another quarter. Somewhat late in the day, many of them are holding out a promise of a place where everybody may go if only the Senate will throw out the present proposal. But no details are given, and the fact that some of the signatories in favour of the new and unknown scheme have been on a syndicate for twelve months charged to prepare a suitable scheme, and have so far failed to meet their own and their friends' requirements, does not inspire much confidence in their future operations. The results of the vote and a forecast of the later developments will appear in the next issue of NATURE.

DR. J. N. PRING, reader in electro-chemistry, University of Manchester, has been appointed head of the Physical Chemistry Branch, Research Department, Royal Arsenal, Woolwich.

SIR RICHARD GREGORY will deliver an address on "Scientific Fact and Popular Fallacy" to the students of the Journalism Diploma course at the University of London, South Kensington, S.W.7, on Monday, December 13, at 5 p.m. The chairman will be Prof. C. H. Lees.

IN connection with the London County Council lectures for teachers, a lecture on "The Antiquity of Man" will be given by Prof. Arthur Keith at the Regent Street Polytechnic, W.1, on Saturday morning, December 18, at 10.30 o'clock. The chair will be taken by Major J. E. K. Studd.

THE University College (University of London) Committee will shortly elect a Quain studentship in biology. The studentship is open to past or present students of the college who have taken a course in botany. The value of the studentship is 150*l.* per annum for three years. Candidates should communicate with the Secretary, University College, Gower Street, W.C.1, before December 16.

THE annual meeting of the Geographical Association will be held at the London Day Training College on Friday and Saturday, January 7 and 8, 1921. There will be a discussion on Historical Geography, opened by Mr. J. Fairgrieve and Capt. W. W. Jervis, and one on Geography in Continuation Schools, opened by Mr. L. Brooks and Capt. V. A. Bell. Dr. Unstead will lecture on The Study and Teaching of International Relations, and Dr. Haddon on Racial and Cultural Distributions in New Guinea. The presidential address by Prof. Gilbert Murray will be delivered on the afternoon of January 8.

AT a time when almost every university and technical institution in Great Britain has to close its doors to new students because of their already congested condition, it is difficult to believe that any circumstances could justify the extinction of a college which has been a pioneer of the most effective type in the work of technical education. Such, however, is the position of Finsbury Technical College, and a defence committee has been formed to consider the possibility of helping in any way to carry on the work of the college and thus to obviate its contemplated closing in July next. The college was given its distinctive character by Profs. Armstrong, Ayrton, and Perry, who were followed by Profs. Meldola and Silvanus Thompson, and the educational methods they introduced were both practical and sound, with the result that every student who took advantage of the opportunities afforded him was well equipped for his work in life. The college was founded by the City and Guilds of London Institute, and has in every way been worthy of its founders. In the last financial year the expenditure was about 12,400*l.*, of which about 7600*l.* was contributed by the institute and 4800*l.* was received in students' fees. It will thus be seen that the students' fees were nearly 40 per cent. of the income expended, which is a much higher ratio than in universities and colleges generally. The average proportion of tuition fees in universities and colleges in receipt of State aid in England and Wales is 28 per cent., and in the United States 10 per cent. Assuming that the City and Guilds Institute contribution is continued, a sum of at least 5000*l.* a year additional is required to enable the college to continue its work, and double that annual amount would not be too much to pay to secure its development. The defence committee has a strong case to put before the City Companies and the public, and it invites all who are interested in the preservation of the college to become members. Applications, with an entrance fee of 2*s.* 6*d.*, should be sent to Dr. Atkinson, Finsbury Technical College, Leonard Street, E.C.2.

Societies and Academies.

LONDON.

Royal Society, November 25.—Sir J. J. Thomson, president, in the chair.—Prof. L. **Hill**: The growth of seedlings in wind. Mustard-and-cress seeds have been grown on lamp-wicks in a continuous wind of approximately 5 metres a second, and the control seeds in still air. The seeds grown in the wind are stunted and bent, and contain less water, more ash, less protein, and, presumably, more cellulose. To counterbalance the drying effect of the wind the seeds have been irrigated with water, and to balance the cooling effect of the wind due to evaporation this water has been warmed, so that a part of the irrigated wick in the wind has been as warm as, or warmer than, the control wick. By the combining effect of thorough wetting and warming the growth of the seeds in wind has been made much more nearly equal to that of the control. While the right amount of moisture is the most important factor, the cooling of the germinating seeds by the wind is also a factor in explaining the stunting of growth in wind-swept places.—Prof. P. T. **Herring**: The effect of thyroid-feeding and of thyroparathyroidectomy upon the pituitrin content of the posterior lobe of the pituitary, the cerebro-spinal fluid, and blood. (1) Neither thyroid-feeding nor thyroparathyroidectomy in cats affects the pituitrin load of the posterior lobe of the pituitary body as tested by the action of similar strengths of extract upon the rat's uterus and the blood-pressure of the pithed cat. (2) There is no evidence of the presence of pituitrin in the cerebro-spinal fluid of the fourth ventricle in normal, thyroid-fed, and thyroparathyroidectomised cats. (3) The defibrinated blood of normal, thyroid-fed, and thyroparathyroidectomised cats has no appreciable action on the rat's uterus. The blood of thyroid-fed cats has a greater depressor action upon the circulation of an anæsthetised cat than has the blood of the normal animal. The blood of thyroparathyroidectomised cats has a pressor effect upon the circulation accompanied by contraction of the kidney and a diminution in the secretion of urine.—W. A. **Jolly**: Reflex times in the South African clawed frog. The reflex times of the homonymous and heteronymous reflexes in the hind limbs of the spinal clawed frog have been measured at temperatures ranging from 14° C. to 30° C. The average heteronymous time (66 observations) is 18·7 σ (0·0187 second). The average homonymous time (68 observations) is 14·9 σ. That is to say, the crossed reflex time is longer than the same-side reflex time by 3·8 σ.—Prof. J. A. **Gunn** and R. St. A. **Heathcote**: Cellular immunity. Observations on natural and acquired immunity to cobra venom. (*a*) *Natural Immunity*.—

The minimum lethal dose of cobra venom for the cat is twenty times that for the rabbit (by subcutaneous injection per kg.). (*b*) *Acquired Immunity.*—When a rabbit is immunised to cobra venom the isolated heart and intestine, perfused with Locke's solution so as to remove the serum, withstand higher concentrations of venom than the heart or intestine of a normal unimmunised rabbit.—L. T. **Hogben**: Studies on synapsis. III.: The nuclear organisation of the germ cells in *Libellula depressa*. (*a*) The nuclear organisation of the germ cells in *Libellula depressa* is investigated with a view to further knowledge of (i) relation of kinetic processes in premeiotic and meiotic phases, and (ii) bearing of nuclear emission in oocyte upon integrity of chromosome complex in meiotic phase. (*b*) In the premeiotic telophase the chromosomes spin out into finely granular loops, displaying initially a polar disposition, becoming increasingly more attenuated in the spirophase, and first recognisable individually in the prophase at attenuated convoluted filaments. (*c*) The Leptotene bouquet is regarded as owing its character to the polarisation of the normal telophase. (*d*) The behaviour of the "double nucleolus" has been thoroughly studied; the plasmosome is independent of the chromatin organisation of the nucleus.

Zoological Society, November 16.—Prof. J. P. Hill, vice-president, in the chair.—Dr. W. A. **Cunnington**: Fauna of the African lakes, with special reference to Tanganyika. After referring to certain physical and geological features which have a bearing on the subject, the nature of the various animal forms inhabiting the lakes was dealt with. Tanganyika was shown to have a very distinctive fauna, in that (1) it includes many more different types than any of the other lakes, (2) an extremely large proportion of them are not found elsewhere, and (3) certain forms (notably Gasteropoda) are considered to have a marine-like appearance. The view previously put forward which regarded the lake as the remains of an old Jurassic sea was considered untenable, since many of the types thought to be marine and primitive belong to essentially fresh-water groups and show signs of specialisation. The Jurassic hypothesis proves likewise incompatible with recent geological evidence. After discussing various other theories, it was suggested that Tanganyika probably owes its remarkable organisms to a prolonged period of isolation, coupled, perhaps, with the effect of an increased salinity which isolation would involve.—H. F. **Carter**: Descriptions of the adult, larval, and pupal stages of a new mosquito from Lord Howe Island, South Pacific.—Prof. C. L. **Boulenger**: Filariid worms from mammalia and birds in the society's gardens, 1914–15.

Institution of Mining and Metallurgy, November 18.—Mr. Frank Merricks, president, in the chair.—C. **Brackenbury**: An automatic counting machine for checking tram-wagons. At a quarry in which the workmen were paid on piecework, their wages depending chiefly on the number of wagons of material sent to the dump and over the weighbridge, the author devised a simple scheme for registering each wagon as it passed up the incline. The upline was provided with catch-rails for the purpose of derailing runaway wagons, and as each wagon passed the open switch the wheel-flanges moved the rail. Suitable levers and wires connected the switch with an automatic counting machine situated in the office, with the result that every complete movement of the switch-rail registered a new unit on the counter. In this manner both the management and the workmen were satisfied that a correct record of the movements of the tram-wagons could be kept.—H. C. **Robson**: Converting high-grade matte in magnesite-lined converters. This paper contains a record of work done at the Spassky Copper Mine, Siberia, where in 1915 two 10-ft. "Great Falls" magnesite-lined converters were installed in place of three 5-ft. acid-lined converters. From the start the new converters were run with the idea of keeping a protective coating of magnesite on the brick lining. This was effected by blowing to white metal a 5-ton charge of matte with flux, followed by a similar amount without flux and 1½ tons of cold matte, the whole being blown to blister-copper. One of the chief difficulties in converting high-grade matte is keeping the tuyères open, especially with slags high in iron and low in silica. From his experience the author can see no reason why any commercial grade of matte should not be treated if correct working conditions be maintained; with matte assaying between 55 and 60 per cent. of copper it was not possible to produce a slag containing less than 6 per cent. of copper. A blister-copper assaying about 98·8 per cent. of copper with a small percentage of sulphur was always produced; attempts to produce copper of a higher grade caused difficulties by the cooling of the charge. The paper contains tables showing respectively the operating data of the converters, analyses of the converter products and by-products, and particulars of the operating temperatures in three trial charges.

Linnean Society, November 18.—Dr. A. Smith Woodward, president, in the chair.—Prof. E. S. **Goodrich**: A new type of teleostean cartilaginous pectoral girdle found in young Clupeids. In the young of *Clupea sprattus*, *C. harangus*, and *C. pilchardus*, about 20–30 mm. in length, the right and left coracoid regions fuse to a solid cartilaginous ventral bar, which becomes bent and again subdivides in later stages. This fusion is probably a specialisation to strengthen the support of the pectoral fins before the complete development of the dermal bones of the pectoral girdle.—Dr. J. C. **Willis**: Endemic genera in relation to others. In a paper of 1916 the deduction was made that in general endemic species of small area were not relics, but species in the early stages of spreading, and much evidence has since been brought up to show the truth of this. It is now proposed to extend this deduction to endemic genera, and to endeavour to show that there is no appreciable difference between a local endemic and an allied genus of wide distribution (of course, working always with groups of genera) other than age. The author has added up all the endemic genera of all the islands in the world, and for comparison also those of (1) West Australia, South Africa, and Brazil (the mainland areas richest in endemics); (2) of Australia, Africa, and South America; and (3) of the world. Examination of the tables thus obtained soon shows that if one takes the families in groups of ten in order according to the number of genera they contain in the world (*i.e.* beginning with Compositae and ending with monotypic families), the proportion of island genera to the total is closely the same throughout the list, and the same holds for all the four areas mentioned. Thus the first ten families contain 40·1 per cent. of the genera of the world, 39·4 per cent. of those of Australia, Africa, and South America, 40·5 per cent. of those of West Australia, etc., and 38·3 per cent. (606 genera out of 1582) of the endemic genera of islands. And the approximation is equally close all down the scale, so that the curves produced almost coincide. Comparison shows with equal clearness that the proportional representation among the endemic genera of islands decreases as one goes down the scale. The first 100 families in the world have island endemic genera in 92, the genera being 12·9 per cent. of the total genera in the families. The intermediate 92 families are represented by 45 only, with 9·28 per cent. of their genera, and the last 100 by 13, with 8·72 per cent.

EDINBURGH.

Royal Society, November 22.—Sir Alfred Ewing, vice-president, in the chair.—Prof. W. **Peddie**: Fechner's law and the self-luminosity of the eye. This law states that the change of visual perceptivity is proportional to the fractional change in the intensity of the light. At weak intensities a term, regarded as constant, has to be added to the intensity of the external light on account of the self-luminosity of the eye. By integration over the whole stimulated part of the retina Helmholtz obtained an expression for the perceptivity which agreed with observation in so far as the general nature of the relation between perceptivity and external stimulus is concerned. There was, however, a measurable difference for a certain range of intensities. A close correspondence can be obtained by assuming that the self-luminosity term in Fechner's expression is itself a simple function of the external stimulus, rising rapidly to a maximum, and thereafter slowly falling to a steady value.—Dr. H. S. **Allen**: Æther and the quantum theory. Although some supporters of the principle of relativity reject the idea of æther, most physicists still employ the æther conception in describing electric and magnetic phenomena. Certain classes of physical facts appear to contradict the laws of classical mechanics, and the quantum theory has been developed by Planck and others to meet such cases. It is argued in this paper that the quantum theory necessitates the physical existence of lines or tubes of magnetic force as discrete entities, and yields a quantitative estimate of what must be the fundamental unit magnetic tube. This unit magnetic tube is determined by the ratio of Planck's constant, h, to the charge, e, of an electron, and is equal to $4{\cdot}12\times10^{-7}$ c.g.s. units. Consequently, one c.g.s. line (one maxwell) contains $2{\cdot}43\times10^{6}$ "quantum tubes." On this theory æther may be regarded as an assemblage of lines of force in accordance with the representation given long ago by Faraday and Maxwell.

PARIS.

Academy of Sciences, November 15.—M. Henri Deslandres in the chair.—C. **Moureu** and A. **Lepape**: The rare gases in natural gases of Alsace-Lorraine. The natural gases examined included five from petroleum wells of Pechelbronn, one from the Wittelsheim potash mines, one firedamp from the Sarre-et-Moselle coal mines, and two from mineral springs (Niederbronn and Soulzmatt). The carbon dioxide, oxygen, combustible gases, and nitrogen (including rare gases) were determined and then the nitrogen was analysed separately. The rare gases were separated into two groups: argon with traces of krypton and xenon, and helium with traces of neon. The argon–nitrogen ratios found varied only between 0·91 and 2·48, but the helium–nitrogen ratios varied much more widely, 23·8 to 2·6.—P. **Théodoridès**: The thermal variation of the coefficient of magnetisation of some anhydrous chlorides and an oxide in the solid state: the magneton theory. Measurements were made on the anhydrous chlorides of cobalt, manganese, and nickel and on manganous oxide at temperatures ranging between 0° C. and 550° C. For the chlorides of nickel and cobalt the results conform to the magneton theory, but this is not the case for the determinations with manganese chloride and oxide.—R. **de Mallemann**: The rotatory power of tartaric and malic acids in solution. Study of the variations in rotatory power produced by the addition of benzene to alcoholic solutions of tartaric acid; the rotations are to the left for all colours, and the dispersion is normal. In aqueous solution this acid reverses its rotation in presence of calcium chloride, and the dispersion, at first abnormal, becomes normal after a certain quantity of the salt has been added. Malic acid resembles tartaric acid and shows similar variations, but in the inverse sense.—E. **Darmois**: The dispersion of the refraction of hydrocarbons. If n and n' are the refractive indices of a given hydrocarbon for two colours, the difference $\frac{n'-n}{d}$, where d is the density, is called the specific dispersion. For different classes of hydrocarbons the differences in the specific dispersion are sufficiently great to be of service in the analysis of mixtures such as occur in petrols.—A. **Bolland**: The micro-chemical reactions of iodic acid. A description of the crystals obtained with iodic acid and salts of thallium, silver, barium, strontium, calcium, and rubidium.—P. **Fleury**: The catalytic decomposition of an alkaline solution of sodium hypobromite by copper sulphate. The opposing action of iodine. The decomposition of the hypobromite solutions was measured by the amounts of oxygen evolved in 1, 2, and 4 days. As little as 0·25 milligram of copper per litre of solution was found to exert a marked catalytic action. This effect can be completely counteracted by adding small quantities of iodine.—C. **Dufraisse**: The ethylene isomerism of the monobromostyrolenes in the lateral chain.—P. H. **Fritel**: The presence of the genera Gangamopteris and Schizoneuta in the grits of Ankazomanga (south of Madagascar). The presence of these plants indicates a lower level of the Permian in Madagascar than that recognised by M. Boule in the Sakamena Valley.—G. **Bertrand**: Observations on the properties of tear-producing substances and the measurement of their activity. Comments on the method used by MM. Dufraisse and Bongrand in a recent communication on the same subject. There are difficulties in the exact definition of the limiting concentration producing effects on the eyes; moreover, the sensibility of the observer varies with the time of day. The mode of attack by the different irritating substances is not the same in all cases; chloropicrin, for example, acts suddenly, whilst the effect of other substances, of which monochloroacetone is an example, is progressive.—A. **Bach** and Mme. Sophie **Zoubkoff**: Contribution to the study of the indices of the blood enzymes. The estimation of catalase, peroxydase, and etherase in one drop of blood.—E. **Kayser**: The influence of luminous radiations on a nitrogen fixer. Cultures of *Azobacter agile* were grown under shades of coloured glass and the nitrogen was assimilated by the bacteria determined. The maximum nitrogen assimilation was under yellow and green light.—J. Y. **Heymans**: *In vivo*, as *in vitro*, micro-organisms pass through the walls of a filter.—L. **Léger**: The endogenous multiplication of *Chloromyxum truttae*.

ROME.

Reale Accademia dei Lincei, June 4.—A. Ròiti, vice-president, in the chair.—S. **Pincherle**: Iterated function of a rational integral one.—G. **Fano**: Surfaces of the 4th order with infinite discontinuous groups of birational transformations, i. The author commences this series of papers with the F/4 containing two skew lines, the first example of the complete study of a group for which Severi's quadratic form is ternary.—G. **Ciamician** and C. **Ravenna**: Considerations regarding the function of alkaloids in plants.—

A. **Angeli** and C. **Lutri**: Black compounds of pirrol, viii.—H. S. **Washington**: Italite, a new leucitic rock. This was discovered by Baron G. A. Blanc and F. Jourdain on the western flank of the volcano of Rocca Monfina in a lava-current more than 100 metres in length.—G. **Andreoli**: Some functional inequalities leading to developments in series.—T. **Boggio**: Lines of force in a stratified spheroid.—C. **Mineo**: Transference of co-ordinates along a geodetic. The formulæ established by the author are applied to a numerical example in geodesy previously calculated by Pizzetti, and are found to agree with his results.—M. **Pascal**: Resultant pressure on a wing of an aeroplane. This is a solution of a hydrodynamical problem in two-dimensional stream-line motion by means of a conformal transformation.—G. **Aliverti**: State of contraction of electrolytic metal deposits, i. Stoney's method is applied to test whether the contraction is or is not due to thermic effects.—E. **Oddone**: Determination of the seismic hypocentre. An empirical formula is established connecting the depth of the hypocentre with the period of the waves of maximum length. As applied to recent earthquakes, this formula gives values for the hypocentric depth of from 9 to 13 km., agreeing fairly well with the known results obtained by more exact methods.—E. **Clerici**: Pelagosite from Canalgrande (Iglesias). This mineral, which was discovered in the form of encrustations on a cavern excavated by the waves, was found to agree in its properties with specimens obtained from Argentario.—L. **Pieragnoli**: Pathology of *Ursus spelaeus* from the caves of Equi. These remains, which were excavated by Prof. Carlo de Stefani, were found to be greatly affected by tuberculosis, showing these animals to be liable to the same diseases as man, and this to an extent which may have been instrumental in causing the extinction of the species.—C. **Artom**: Biology of the genus Artemia.—L. **Petri**: Cause of arrested development of the ovary in the olive. According to Dr. Pirotta, olive-trees could be classified into four distinct types, characterised by the presence or absence of sterile or fertile flowers, flowers with imperfectly developed ovaries, or mixtures of these forms. The author disagrees with Dr. Pirotta's theory, and maintains that the arrested development of the ovary is a phenomenon common to all varieties of wild and cultivated olives, which may be brought about by extraneous temporary causes of recent date. The conditions favourable to the production of the different forms of flowers remain to be determined.—A committee, consisting of L. Luzzatti, G. de Marchi, and R. Pirotta (recorder), presented a report on Dr. Girolamo Azzi's proposals for dealing with meteorological and geographical problems relating to agriculture.

Books Received.

The Principles of Economic Geography. By Dr. R. N. Rudmose Brown. Pp. xv+208. (London: Sir Isaac Pitman and Sons, Ltd.) 10s. 6d. net.

Infant Education. By Dr. E. Pritchard. Second edition. Pp. xv+226. (London: H. Kimpton.) 6s. net.

Physiology and Biochemistry in Modern Medicine. By Prof. J. J. R. Macleod. Third edition. Pp. xxxii+992+9 plates. (London: H. Kimpton.) 42s. net.

The Yeasts. By Prof. A. Guilliermond. Translated by Dr. F. W. Tanner. Pp. xix+424. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 31s. net.

Handbuch der Regionalen Geologie. Edited by Prof. G. Steinmann and Prof. O. Wilckens. 20 Heft, III. Band, 1 Abteilung.: The British Isles. By P. G. H. Boswell and others. Local Editor, J. W. Evans. With an Appendix, The Channel Islands, by J. Parkinson. Pp. 354+plates. (Heidelberg: Carl Winter.)

Nucleic Acids. By Prof. W. Jones. Second edition. Pp. viii+150. (London: Longmans, Green and Co.) 9s. net.

Bolshevik Russia. By G. E. Raine, in collaboration with Dr. E. Luboff. Pp. 192. (London: Nisbet and Co., Ltd.) 1s. net.

London Trees. By A. D. Webster. Pp. xii+218+32 plates. (London: Swarthmore Press.) 15s. net.

Medical Research Council and Department of Scientific and Industrial Research. Reports of the Industrial Fatigue Research Board. No. 10: Preliminary Notes on the Boot and Shoe Industry. Pp. 32+vii plates. (London: H.M. Stationery Office.) 1s. 6d. net.

A Last Diary. By W. N. P. Barbellion. Pp. xlviii+148. (London: Chatto and Windus.) 6s. net.

Ancient Egypt. Part 4, 1920. (London: Macmillan and Co., Ltd.) 2s. net.

Prevention of Venereal Disease. By Sir G. Archdall Reid. Pp. xviii+447. (London: W. Heinemann, Ltd.) 15s. net.

Science German Course. By G. W. P. Moffatt. Third edition. Pp. xii+270. (London: W. B. Clive.) 5s.

Practical Biological Chemistry. By Prof. G. Bertrand and P. Thomas. Translated from the third edition by H. A. Colwell. Pp. xxxii+348. (London: G. Bell and Sons, Ltd.) 10s. 6d. net.

Highways and Byways in Northumbria. By P. A. Graham. Pp. xviii+380. (London: Macmillan and Co., Ltd.) 7s. 6d. net.

The League of Nations Starts. An Outline by its Organisers. Pp. xi+282. (London: Macmillan and Co., Ltd.) 10s. 6d. net.

Diary of Societies.

THURSDAY, DECEMBER 9.

ROYAL SOCIETY, at 4.30.—Lord Rayleigh: Double Refraction and Crystalline Structure of Silica Glass.—Prof. J. W. Nicholson and Prof. T. R. Merton: The Effect of Asymmetry on Wave-length Determinations.—Prof. T. R. Merton: The Effect of Concentration on the Spectra of Luminous Gases.—Prof. E. Wilson: The Measurement of Low Magnetic Susceptibility by an Instrument of New Type.—Prof. W. T. David: The Internal Energy of Inflammable Mixtures of Coal-gas and Air after Explosion.—Prof. A. McAulay: Multenions and Differential Invariants.

LINNEAN SOCIETY, at 5.—Prof. R. Newstead: Uganda Biology (Lantern Lecture).

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—S. Beatty: The Algebraic Theory of Algebraic Functions of One Variable.—F. Debono: The Construction of Magic Squares.—Prof. A. S. Eddington: An Application of the Calculus of Tensors to the Theory of Finite Differences.—Prof. A. R. Forsyth: Developable Surfaces through a couple of Guiding Curves in Different Planes.—J. E. Jones: The Distribution of Energy in the Neighbourhood of a Vibrating Sphere.—L. J. Mordell: (1) The Reciprocity Formula for the Gauss's Sums in a Quadratic Field. (2) A New Class of Definite Integrals.—Prof. G. N. Watson: The Product of Two Hypergeometric Functions.—Prof. W. H. Young: (1) Integration over the Area of a Surface and Transformation of the Variables in a Multiple Integral. (2) A New Set of Conditions for a Formula for an Area.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.15.—Dr. Max Porges: Mud Baths and Nephritis.—Dr. F. Hernaman-Johnson: The Importance of Combined Methods in Diagnosis and Treatment.—Dr. S. Borridge: Some Possible Ill-effects of Barium Waters.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Adjourned Discussion on Papers by W. B. Woodhouse and R. O. Kapp on The Distribution of Electricity and Some Economic Aspects of E.H.T. Distribution by Underground Cables.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Dr. F. Hussard: Tabes, its Early Recognition and Treatment.

FRIDAY, DECEMBER 10.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in the Botanical Theatre, Imperial College of Science), at 2.30.—Exhibition of Specimens and Short Communications.—W. J. Dawson: Problems of Economic Biology in British East Africa.—Dr. M. C. Rayner: Nitrogen Fixation in the Ericaceæ.

ROYAL ASTRONOMICAL SOCIETY, at 5.—J. K. Fotheringham: A Solution of Ancient Eclipses of the Sun.—W. H. Wright: The Displacements of the Hydrogen Absorption Lines in the Spectrum of Nova Geminorum in March, 1912, with Remarks upon their Interpretation.—H. C. Plummer: The Question of Stationary Radiants.—Rev. J. G. Hagen: A Map showing Obscure Nebulæ and their Situation towards the Milky Way.—P. H. Hepburn, M. A. Ainslie, W. H. Steavenson, and H. L. Waterfield: Observations of Saturn, 1920, November 6 to November 20.—C. D. Perrine: Cepheid Variation: Acknowledging a Correction and Some Further Considerations.—C. D. Perrine: Behaviour of Radiations at λλ 4634-41 and at λ 4654 in the Wolf-Rayet Stars.—C. D. Perrine: Presence of Emission at λλ 4634 and 4641 in the Spectra of the Wolf-Rayet Stars.

PHYSICAL SOCIETY OF LONDON, at 5.—J. St. Vincent Pletts: Some Slide Rule Improvements.—N. A. Allen: The Current Density in the Crater of the Carbon Arc.—F. H. Newman: A Sodium Vapour Electric Discharge Tube.—F. H. Newman: Absorption of Gases in the Electric Discharge Tube.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.

TECHNICAL INSPECTION ASSOCIATION (at Royal Society of Arts), at 7.30.—Dr. G. H. Gulliver: Some Features of Tensile Fractures.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.

MONDAY, DECEMBER 13.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Lt.-Comdr. R. T. Gould: The History of the Chronometer.

ROYAL SOCIETY OF MEDICINE (War Section), at 5.30.—Surg.-Comdr. E. L. Atkinson: Snow Blindness: Its Prevention, Cause, and Treatment.

INSTITUTION OF ELECTRICAL ENGINEERS (at Chartered Institute of Patent Agents, Staple Inn Buildings), at 7.—W. J. Minton and Others: Discussion on (1) Percentage and Accuracies; (2) Meter Constants and Standards; (3) Name-plates.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Meeting), at 7.—A. G. Hopking: Die Casting.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—M. S. Briggs: Saracenic Architecture in Egypt and Palestine.

ROYAL SOCIETY OF ARTS, at 8.—A. Chaston Chapman: Micro-organisms and Some of their Industrial Uses (Cantor Lecture).

INSTITUTE OF BREWING, at 8.—H. Lloyd Hind: The Reconstruction of French Breweries.

CHEMICAL INDUSTRY CLUB, at 8.—Dr. W. R. Ormandy and Others: Discussion on Phosphorescence and Invisible Light.

SURVEYORS' INSTITUTION, at 8.—F. H. A. Hardcastle: The Work of the Measuring and Quantity Surveyor, and the Use and Abuse of Bills of Quantities.

FARADAY SOCIETY (at Chemical Society), at 8.—Annual General Meeting.—At 8.15.—Prof. E. D. Campbell: A Force Field Dissociation Theory of Solution applied to Some Properties of Steel (Discussion to be opened by Dr. A. E. Oxley).—A. L. Norbury: The Electrical Resistivity of Dilute Metallic Solutions.—W. E. Hughes: The Forms of Electro-deposited Iron and the Effect of Acid upon its Structure. Part I. Deposited from the Chloride Bath.

TUESDAY, DECEMBER 14.

ROYAL HORTICULTURAL SOCIETY, at 3.

ROYAL SOCIETY OF MEDICINE (Therapeutics and Pharmacology Section) (at Mount Vernon Hospital), at 4.30.—Dr. W. E. Dixon: Quinine Derivatives as Local Anæsthetics.—Dr. O. Inchley: Absorption of Drugs by means of the Electric Current.—Dr. W. E. Dixon and Dr. D. Cow: Actions of Isomeric Methyl Chlorides of Tellurium.

ROYAL SOCIETY OF MEDICINE (Medicine Section) (at London Hospital), at 5.—D. Hunter: The Results of Fractional Test Meals on Patients.

ROYAL STATISTICAL SOCIETY, at 5.15.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—Capt. P. W. Mangin: Boring in Palestine.—F. Ealing: Estimation of Sulphur by the Lamp Method.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—Sir Robert A. Hadfield, Bt., and S. A. Main: Notes on the Standardisation of Shock Tests, and Discussion on this Paper and on the three Papers on Notched-Bar Tests read at the Meeting on November 30.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.

QUEKETT MICROSCOPICAL CLUB (at 11 Chandos Street, W.1), at 7.30.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—Report on Progress during the Vacation, and an Exhibition of New Developments in Lamps and Lighting Appliances, Illumination-photometers, etc.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Capt. L. W. G. Malcolm: The Ethnography of the Central Cameroons.

WEDNESDAY, DECEMBER 15.

SOCIETY OF GLASS TECHNOLOGY (at Royal Society of Arts), at 2.30.—W. A. Whatmough: The Re-Annealing of Glass.—Dr. C. J. Peddle: The Development of Various Types of Glass. Parts VI., VII., VIII., and IX.: Silicate Glasses containing Sodium Oxide, Potassium Oxide, and Lead Oxide.

OPTICAL SOCIETY (at National Physical Laboratory), at 3.30.—Dr. J. S. Anderson: Photographic Shutter Testing; Testing of Objectives; Differential Refractometry for Liquids; Immersion Refractometry.—J. Guild: Curvature Measurements; Note on Pyramidal Error in Prisms; Note on the Corrections for Temperature and Atmospheric Pressure in Refractometry.—J. Guild and Miss A. B. Dale: Critical Angle Refractometry.—T. Smith: The Dispersion of Glass and the Determination of Probable Corrections to Observations; Notes on the Calculation of Multiple-Glass Objectives.—T. Smith and G. Milne: A Recalculation of the Objectives of Steinheil and Voit, with additions.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. T. O. Bosworth: The Tertiary and Quaternary Geology and Tectonics of the Littoral of Peru.—H. Woods: The Fauna of the Tertiary Deposits of Northern Peru.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section) (at Institution of Civil Engineers), at 6.—Capt. R. C. Trench: Range of Wireless Stations.

ROYAL MICROSCOPICAL SOCIETY (at Mortimer Halls, Mortimer Street), at 7.30.—Conversazione.—At 8.—Ordinary Meeting.

ROYAL SOCIETY OF ARTS, at 8.—Major-Gen. Lord Lovat: Forestry.

INSTITUTE OF CHEMISTRY (London and South-East Counties Section) (at 30 Russell Square), at 8.—Annual Meeting.

ROYAL METEOROLOGICAL SOCIETY, at 8.—Capt. C. K. M. Douglas: Temperature Variations in the Lowest Four Kilometres.—A. P. Wainwright: A New Form of Sunshine Recorder (Mechanical Type).—Lt.-Col. J. E. E. Craster: An Investigation of River Flow, Rainfall, and Evaporation Records.

THURSDAY, DECEMBER 16.

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INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—E. J. Prior: Some Sources of Error in Alluvial Boring.—R. E. Palmer: Some Observations on Mining by the Opencast or Stripping Method.

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NATURE

THURSDAY, DECEMBER 16, 1920.

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The Practical Teaching of Science.

THE resumption by the Board of Education of the publication of memoranda prepared for the Office of Special Inquiries and Reports is to be welcomed. Before the war a constant stream of valuable information on educational progress and experiment at home and abroad issued from this source, and if not much more came of each individual contribution than is expected from the reports of most Government inquiries, these memoranda were, in the mass, sensibly affecting educational thought and practice. The war inevitably checked the stream in its course, and it is one more encouraging sign that we are, however slowly and painfully, returning to a time of peaceful development, or at least preparing for such a return, when we note that the stream has begun to flow again.

The recent appearance of a modest pamphlet, in the familiar green paper covers, entitled "Some Experiments in the Teaching of Science and Handwork in Certain Elementary Schools in London,"[1] is of peculiar value at the present moment. It is true that the experiments described were cut short by the war, but it is important that the conclusions to be drawn from them should be studied now, when not only in elementary and central and secondary schools, but also in the new day continuation schools, we are faced by the problem how best to combine efficiency and economy in the effort to stimulate intellectual development through science, not as an isolated study, but as a branch of the humanities. Before 1914 we had tended to give up the idealistic dream that if all schools were fitted up with laboratories, or had access to laboratories, equipped for the academic study of chemistry and physics, progress was assured. The view was winning acceptance that for perhaps most young people the best approach was through the motor activities, through carrying out in practice the general idea of "teaching science by making things," or, in other words, discovering scientific principles by solving practical problems. The idealist had come to earth, and we may hope that if his head remains in air his feet will continue to feel the ground he walks upon.

In the report which we have now before us the claim is made that the experiments carried out in the higher classes of elementary schools and in central schools, the latter of which take young people on to about sixteen years of age, go to show that a scheme of instruction in science which is based largely on handwork, and makes no excessive demand on theory, is far wider in scope than has hitherto been suspected. But the report only confirms the lessons to be drawn from two earlier reports—the invaluable "Manual Instruction in Public Elementary Schools," issued in 1910, and, on a higher plane of studies, the "Report on Science Teaching in Public Schools," issued in 1909—the most striking scheme in which was one where handwork and brainwork went on together.

The claim now definitely made is one which is entitled to respect because it is enunciated, not by any mere theorist spinning theories as he contemplates the ceiling through a cloud of tobacco smoke, but by skilled observers speaking on behalf of actual practitioners in the art of teaching. The principle involved is commended to the earnest consideration of those who are anxiously thinking out what kind of practical rooms and what sort of laboratories are to be installed in the new part-time day continuation schools for young people between the ages of fourteen and sixteen who spend most of their time in the office or workshop and only a precious seven or eight hours a week in school. They have the choice between text-book instruction supplemented by a modicum of experiment in a formal laboratory and practical instruction in a workshop which is equipped with the essential fittings of a laboratory. They may well come to the conclusion that,

[1] Educational Pamphlet No. 36. Pp. 34. (H.M. Stationery Office.) Price 1s. net.

while for those who have before them years for continuous study the former method is to be commended, with those who have but an hour or two a week in which to quicken their scientific appreciation a sound working knowledge of a far wider range of scientific phenomena, *with a bearing upon daily experience*, can be gained under a system which combines the workshop and the laboratory than by the conventional text-book treatment of science.

Such is the problem before us, and a possible solution, stated in their simplest terms. As regards elementary education, the question is settled so far as Governmental authority is concerned by the requirement of the Act of 1918 that every local education authority must make suitable provision for the practical instruction of older children. If this practical instruction is to have an educational significance beyond the mechanical repetition of manipulative exercises, however useful in themselves, then the illustration, the working out in concrete materials, of scientific principles or formulæ must be the very basis. For the older children in elementary schools, and also on the industrial side of central schools, such a compromise between the laboratory and the workshop is inevitable. In county boroughs and urban districts, where large, well-equipped centres are possible, the laboratory and the workshop may be separate rooms, provided that the intimate relation of one to the other is recognised, so that the problem set and illustrated in the laboratory is worked out at the bench, or, conversely, the process employed in the workshop is dissected and its principle revealed in the laboratory.

This is precisely what is going on in the one new type of school which has been evolved in this twentieth century of ours. Junior technical schools are very different from the preparatory trade schools or pre-apprenticeship schools which they are generally supplanting. Their purpose is to give a young person intending at sixteen to take up an apprenticeship in some branch of the engineering or building trades or professions, even architecture or naval architecture, not only a humanistic training in English subjects (and, for the brighter intelligences, in a foreign language), but also a firm foundation in mathematics, in mechanical drawing, and in the abstract principles underlying that branch of applied science popularly known as "mechanics," on which they may build their careers—some going no further than to become the foremen of industry; others, during or at the end of their apprenticeship, proceeding to university courses and becoming the Kelvins and Moultons of the future.

Even in the sphere of adult education which is opening out before us there is scope for work on these comparatively simple and unambitious lines. The intelligent artisan who awakes to deficiencies in his early education and is anxious to improve his scientific equipment will often find the initiation into natural philosophy easier by way of the laboratory workshop than through the lecture theatre and the merely experimental laboratory. But here the argument must not be pressed too far, for the greatest is he who is able on reaching man's estate to venture into strange seas of thought alone, and the man of science is great who approximates to that higher and more abstract ideal.

Vitalism versus Mechanism.

The System of Animate Nature: The Gifford Lectures delivered in the University of St. Andrews in the Years 1915 *and* 1916. By Prof. J. Arthur Thomson. (In two volumes.) Vol. i. Pp. xi+348. Vol. ii. Pp. v+349-687. (London: Williams and Norgate, 1920.) Price 30*s*. net two vols.

THE subject of the Gifford lectures was intended by the founder to be natural theology regarded as a natural science and treated, just as astronomy or chemistry would be, with entire freedom from any prepossessions whatever. This rather difficult task has been attempted by two biologists, Dr. Hans Driesch in 1907–8, and Prof. J. Arthur Thomson in 1915–16. The first of these lecturers tells us that he set out to follow biology along its own path—that is, from its nineteenth-century "naïve realism" towards its transition to "a branch of the philosophy of Nature," and such a progress he accelerated in no small degree by a method of treatment that was both critical and constructive. It was critical inasmuch as it included a penetrating analysis of the nature of the transformations that occur in living substance, thus leading to the rejection of the notion of a peculiar "vital energy form," and—which is equally important—it involved also a thorough criticism of the "pseudo-psychology" that had been employed in the study of animal behaviour. But it was also constructive in that it developed an old concept—that of "entelechy"—deriving from this a series of "psychoids" which were regarded as factors in organogenesis, metabolism, and behaviour. The Drieschian psychoids are not energetic agencies, but they function, as Leibnitz suggested in regard to the human soul, like a wise prince among his subjects, or a good father in his household, by directing, suspending, and releasing activities rather than by exerting them.

Now, after this strong and tough fare purveyed by Driesch, Prof. Thomson's book may almost be called "light reading"; clearly it could not have been written from an easy chair, but it can easily be read in such. The aim of a study of animate Nature, Prof. Thomson tells us, "is to state the general results of biological inquiry which must be taken account of if we are to think of organic Nature as a whole in relation to the rest of our experience," and it is just such a survey that he presents to us in a most agreeable manner. There is no inclination to make, or adopt, a system, and the criticism is seldom very penetrating. One is told what is meant, in contemporary literature, by the ideas of "Body and Mind," "Organism and Mechanism," "Adaptiveness and Purposiveness," "Disharmonies and Shadows" that prevent us from seeing, in the organic world, "the True, the Beautiful, and the Good," and so on. But, in the main, the discussion centres round the contrasted hypotheses of mechanism and vitalism.

What is vitalism? There are at least three grades, the author says. First there is a recognition that the physico-chemical processes that go on in inorganic materials cannot explain animal behaviour; knowing only the former, we cannot predict the latter. This is the "very thin edge of vitalism." Next there is the view that some particular "vital force," or mode of energy, operates in living substance, but not elsewhere. Lastly, it has been thought that the organism is the seat of a non-energetic factor, or entelechy. This is "thorough-going vitalism." In addition to these hypotheses there is Mr. E. S. Russell's "methodological vitalism"—a biological fact, such as a migration, is a unique activity which has to be explained. It is not explained by decomposing it into an infinity of physico-chemical reactions, for then the fact itself disappears, and we are left only with a great number of little, partial views or aspects of it, which are, no doubt, expressions of a mechanism of matter and energy, but not the thing itself. We must, therefore, study animal behaviour, not as a series of energy-transformations or even as the result of the operation of mind, but as irreducible data to be dealt with by themselves. This Prof. Thomson regards as the most satisfactory attitude yet suggested, and there can be little doubt about that; it is a method rather than an "ism," and its outcome is investigation.

What is mechanism? As usually understood, the mechanistic conception of life states that the activities of organisms are physico-chemical —and nothing else. The notion comes down to us from Descartes, who recognised nothing in the organic world but matter and its configurations and motions (for, even when he placed the "sensitive soul" in man, he did not regard that as essential to animality). Now, matter, when *our* hypothesis of mechanism was elaborated, meant the chemical atoms; its configurations were chemical compounds, and its motions the expressions of energy-transformations. How to deal with consciousness on this hypothesis was always difficult, but, as a rule, the thorough-going mechanist ignored the condition, and regarded as "realities" only objective things and processes. This was called "monistic panhylism" —which sounds well, at all events.

Whichever of these attitudes one takes up (for a biologist is expected to be either a mechanist or a vitalist) depends on one's education and its media, and also upon one's temperament. Thus Prof. Thomson "confesses to some sympathy with those who ask why there should be all this straining and striving to remove organisms from the domain which includes the stars and precious stones, Northern Lights and dewdrops"; but he does not think that mechanism "exhausts the reality of the earth and the heavens, still less that of the flower in the crannied wall." On the other hand, Prof. D'Arcy Thompson is "not ashamed to uphold" that "the earth itself and the sea, the earth with its slowly changing face and the sea multitudinous with all its tides and currents and great and little waves, constitute a mechanism; the heavens themselves, the sun and moon and all the little stars, are a glorious mechanism." Obviously, having to make the choice induces sentiment. Now it would not be rash to say that the difference between mechanism and vitalism may suggest that between the Homoousians and the Homoiousians, but, like Gibbon when he wrote about the Arian controversies, one fails to trace any "real and sensible distinction" between the "isms" that concern us here. What does one find if he tries to think it all out in the light of strictly modern, physical speculation? Does "determinism" mean anything at all in science? It is "strict" only when we deal with mathematical functionality, and even then is not that just because the human mind, *having made the rules*, expects the answer? Obviously, this "ism" is a method, and not a result. Then, again, it is still very convenient to speak about atoms, etc.; but in pure speculation (which is our field just now) we must get down to bedrock conceptions. *Then* the ultimate data of science are not even space-time coincidences, and not even the *dx's*, *dy's*, *dz's*, and *dt's* (for these can have significance only when they are referred to other *dx's*, etc.), but the relations between these unsubstantial ghosts of reality and other similar ghosts. And are not these relations most obviously the products of the mind? If so, is not our mechanism at the same time also vitalism?

Plainly, then, there is occasion for strong and resolute thinking in biology, as well as in physics, and until that has been done there ought to be an end to these back-number controversies. One fails to find this in Prof. Thomson's book, but, none the less, it is a book that most certainly ought to have been written. It takes stock, so to speak, of the situation of speculative biology at the beginning of a new phase in science, and it does so in a manner that is candid, comprehensive, and most attractive. Even to have compiled the bibliography, for which a host of young biologists will be thankful, is worthy of the gratitude of both students and investigators. J. J.

A Study of Weeds.

Weeds of Farm Land. By Dr. Winifred E. Brenchley. Pp. x+239. (London: Longmans, Green, and Co., 1920.) Price 12*s.* 6*d.* net.

IT is a healthy sign of the broad-minded, practical way in which agricultural research is being conducted that this handsome book on weeds should come from Rothamsted. It is necessary to employ the utmost refinements of mathematical and physical discussion in order to determine the water-retaining power of soil particles, and to make recurring counts of the bacteria and other organisms present in a gram of soil, if the expert is to be furnished with the data he requires in order to advise the farmer on the manuring and cultivation of his soil. But the best of manures will fail of effect if the land is not clean, and agricultural investigators run the danger of performing harmonics on the academic string if they do not constantly vitalise their thinking by watching the farmer at work and learning from him where the real difficulties arise.

Dr. Brenchley's book deals with weeds, and introduces us straightway to a big, and as yet an unsolved, problem—that of competition among living plants. As Rothamsted showed years ago, all the improvements in our agricultural plants, that selection for immense vegetative capacity which makes them such excellent productive machines, have not fitted them in the least to stand competition. When the wheat crop on a part of the Broadbalk field was left unharvested to sow itself and recur to the wild life of struggle, it persisted for only three seasons. By that time the weeds had taken possession of the land, and the wheat could hold its own no longer. A weed is nothing more than a plant which can scratch a living under the stress of competition with cultivated crops and in spite of the wholesale destruction wrought by tillage operations.

Dr. Brenchley begins her book with a description of the devices by which weeds ensure their continuance and distribution. Some, like the poppies, depend on the abundance of their seed; others, like the dandelion, have developed a plume or other device to spread wide their seed; others, again, like the creeping thistle or couch grass, possess a creeping underground stem which will yield a plant from every fragment. This part of the philosophy of weeds is easy; we can see why particular weeds are abundant, but why other equally well endowed plants do not become weeds is less evident. As in other domains of thought, teleology is a fine weapon of argument until someone reverses it. There are other factors in competition we do not in the least understand. Why should certain plants, chiefly European, harmless enough at home, have such a deadly power of spreading and becoming weeds in the worst sense when they are let loose in Australia or America? The prickly pear has rendered millions of acres unusable by man or beast in Queensland; every new country shows some invader in impudent possession, "having the time of its life."

The factors in competition are as yet beyond our summing; some slight reaction to soil or climate may depress or improve the "constitution" of the plant to a degree that is not apparent and certainly not susceptible of measurement, yet that slight change does determine whether the plant can or cannot stand competition. Dr. Brenchley supplies an example in point. Spurrey and sheep's sorrel are perhaps the most useful of indicator weeds—sure signs of soil acidity and lack of lime. Spurrey may be said never to be seen on chalk soils; on the sour Bagshot sands it will overwhelm the wheat. Yet these plants, when grown in pots and plots free from competition, grow better in limed or chalky soils than in their natural medium. The same thing has been observed with the calcifuge leguminous plants.

The latter part of Dr. Brenchley's book is occupied with a discussion of the association of particular weeds with soils, especially arable soils, a question of which she has made the first systematic study, and thereby upset a good many statements that had been put out on insufficient observation. Many of the results are still contradictory and far from conclusive; in fact, this is a field of applied ecology demanding further study. Within a given climatic zone we ought to be able to associate soil types with weeds, and so prepare a soil map accurate enough for working purposes from surface observations of the arable land flora alone, with quite a limited amount of checking by analysis.

Another question to which Dr. Brenchley devotes a good deal of attention is that of the viability of seeds as bearing on the unexpected flora which often appears on the bared surface of a railway cutting, a newly ploughed field that has been long in grass, or even the spoil heap of subsoil from a well or a ditch. Rank luxuriant charlock almost invariably springs up, yet it is difficult to see either how that somewhat heavy seed could be carried there, or that it could have been dormant in the soil. Charlock has been observed to cover a piece of newly ploughed moorland, broken up for the first time in its history so far as was known, and remote from any other arable land. The oldest inhabitants always know that certain fields will be smothered with charlock if they are ploughed deep, or broken up from grass after a long term of years. Yet the viability of seeds when stored is not great, nor do Dr. Kidd's experiments on the retarding effect of carbon dioxide on germination quite decide the question. Under ordinary conditions a seed continues to respire as long as it is alive; in the long-stored wheats at Rothamsted, for example, the embryo is burnt out, as it were. But under suitable conditions—say, of the carbon dioxide content of the air—can the seed assume a static condition and yet retain its germinating capacity, its life, for an exceptional term of years? Dr. Brenchley's figures for the number of arable seeds that germinated in samples of soil from different depths taken from land which had been down in grass for various periods indicate a progressive dying off of the buried seed, the numbers being comparatively few after thirty years of grass. But the subject would repay further study, especially as regards charlock.

One of the best of Dr. Brenchley's chapters deals with the prevention and eradication of weeds; they may be summed up in good cultivation and a sound rotation; smother crops are only effective to keep, not to make, land clean. Chemical methods have their occasional uses, like spraying with copper sulphate solution for charlock, but no farmer should need them after he has once got his land in order.

Dr. Brenchley's book should find its place in all agricultural libraries; it has the vividness and interest of the record of personal observation and thought that no mere compilation ever possesses. A word of praise should also be given to the illustrations; the photographs of parasitic plants attached to their hosts will be of interest to many botanists, while the drawings are new and characteristic.

A. D. H.

Facts and Theories for the Social Worker.

(1) *An Introduction to Sociology: For Social Workers and General Readers.* By Prof. J. J. Findlay. Pp. xi+304. (Manchester: At the University Press; London: Longmans, Green, and Co., 1920.) Price 6*s.* net.

(2) *The Social Worker.* By C. R. Attlee. (The Social Service Library.) Pp. viii+286. (London: G. Bell and Sons, Ltd., 1920.) Price 6*s.* net.

(1) "THE 'unit' in sociology is the group." Throughout this "Introduction to Sociology" the author holds fast to this basal conception, and amid his many excursions into varied fields of study he is constantly turning back to the "group," unfolding its many implications, and by its means striking a path "through the jungle of social questions."

In this treatment of the group conception emerges the author's view that "the political philosophers have been far too prone to present an antithesis between The State and The Individual, whereas the conflict should always be viewed as between The State and The Voluntary Group." The former method gives a false superiority to the State, and begs the question of the place of the other groups in the life of the community. But if we throw over the supreme authority of the State we are left with two alternatives, neither of which seems satisfactory. We may elevate some other group to the highest place; the Syndicalist, for example, would make the group of producers supreme. That way lies no solution, for the association of producers is less representative than the State as it exists at present. We may, on the other hand, with Mr. G. D. H. Cole, attempt to balance the producers' association (The National Guild) by a consumers' association; but even so we are driven to look for a third group with authority over both; and Mr. Cole's *tertium quid* resolves itself into something not unlike our present State. Prof. Findlay does not aim at a final solution of this problem. "A new region," he says, "now awaits to be explored; . . . the various groups which, under the ægis of the democratic State, have developed self-consciousness and power, must now be brought into harmonious relation with each other and with the

State which claims to be their master." But in his discussion there is much that is suggestive and illuminating.

In his chapter on occupation and leisure the author finds the contrast between profession and trade to lie in the fact that the former is based on service, the latter on exchange, and he sees hope for the future in the thought that "society has never accepted the economic basis." Industry must be professionalised. This can be done—it was done during the war—through the trade unions and the employers' associations realising that they exist "to do the work of the trade, to produce the goods."

The book is fresh, alive, and interesting. The author holds that we "must begin with the present: describing and defining what we witness with all the power of abstraction we possess." Hence we find less in this book about the Todas and more about the League of Nations than in most treatises on sociology. Perhaps for an "Introduction" its very facility will prove to some extent a drawback. The simplicity of outline which the beginner demands is lost in the wealth of illustration and in the multitude of apt comments in many spheres of present and past experience. But the system is there if the reader has the wit to come by it; and the student of sociology who reads the book will go back to his task with renewed vigour.

(2) It is not very long since the only picture called up by the term "social worker" was that of an unprepossessing female, of uncertain age, but of undoubted respectability, who periodically descended from her refined atmosphere to view the lives of those strange beings "the poor." But the rapid extension of the sphere of State activity; the devolution of administrative functions to local bodies, and of advisory, and sometimes of executive, functions to workers, voluntary and official, paid and unpaid; the quickening of the social consciousness of the Church; and, perhaps most of all, the awakened self-consciousness of the working classes, no longer content to be experimented upon, but resolved to work out their own solution of whatever social ills they are heir to—all this has made the ordinary citizen aware to a fuller extent than ever before of his social responsibilities. If we are not all "social workers," we have at least come to pay tribute to the value and the difficulty of the services which the "social worker" performs.

Major Attlee in his book explores the wider denotation of the term. He reviews the opportunities for social service, in the charitable society, the prison, the mission, and the Church; in connection with the Poor Law, the Labour Exchange, the Care Committee, the Public Health bodies; and even in the trade union, the friendly society, and the co-operative society. All these are grist to Major Attlee's mill; and rightly so. The social fabric has become self-conscious through and through, and since in this new age these activities must be performed, it is desirable that they should be performed with intelligence and enlightenment. The book is full, racily written, and made alive with interesting first-hand illustration. Not only to the aspiring social worker, but also to those who are old in the service, and to the ordinary citizen, the book should prove a mine of information and a particularly inspiring example of the spirit in which the social worker should pursue his task.

The volume is the first of a series to be entitled "The Social Service Library" and edited by the present author. We look forward with interest to the publication of the other volumes in the series.

Our Bookshelf.

A Dictionary of Scientific Terms: Pronunciation, Derivation, and Definition of Terms in Biology, Botany, Zoology, Anatomy, Cytology, Embryology, Physiology. By I. F. Henderson and Dr. W. D. Henderson. Pp. viii+354. (Edinburgh and London: Oliver and Boyd, 1920.) Price 18*s*. net.

THE present work contains definitions of about 10,000 terms, including several hundred lately coined expressions, many of which have not hitherto appeared in a dictionary. In a first edition all the attempts at definition are not likely to be happy: "cœlom" is "a cavity of the body derived from the mesoblast"; "cœlomoduct," "the duct leading directly from the genital cavity to the exterior in Cephalopods and in Annulates"; "nephridium," "any excretory organ, usually the excretory organ of Invertebrates"; "micronephridia" is not given, though the obsolete and misleading "plectonephridia" appears; "sclerotome," "a partition of connective tissue between two myotomes"; "notochord" is not given, though "vertebra" is; "acanthin," "a substance like chitin, strontium sulphate, forming the skeleton of the Radiolarians"; "nanoplankton," "microscopic plankton"; "entelechy," "the realisation of forms in plant and animal life which have the power of reproducing their kind."

Alternative pronunciations are frequently given, as "different centres of learning have different types of pronunciation"; but one may seriously question the admissibility of many of these—*e.g.* of accenting "abdomen" and "gluteus" on the first syllable, or "popliteal" on the second, or "madreporite" and "mediastinum" on the third; while the only pronunciations given for "lorica," "vesica," and "posticous" (on the first syllable) are frankly impossible. To neglect the established "rules of the game" in this matter is merely to encourage anarchy. "Anlage" should be accented on the first syllable.

The preparation of a dictionary of so many different sciences and subsciences is a formidable undertaking for two authors; the writers have, however, attained a considerable measure of success.

The Evolution of a Coast-line: Barrow to Aberystwyth and the Isle of Man, with Notes on Lost Towns, Submarine Discoveries, etc. By W. Ashton. Pp. xvi+302. (London: Edward Stanford, Ltd.; Southport: W. Ashton and Sons, Ltd., 1920.) Price 10s. net.

The author gathers every possible kind of evidence to prove that there has been a widespread downward tendency in the land levels of the western coast of Britain, which has continued from a beginning, one gathers, after Neolithic times. He has read widely and with profit, though not always with discrimination, but his book will be of value to students, especially if they also have Sinel's "Geology of Jersey" to consult alongside it. The coast is considered section by section with, frequently, a popular geological introduction. The author works out a conjectural map of some ancient coast-lines, such as that of Cardigan Bay, which he suggests was once all lowland, and the land of the famous story of the Lowland Hundred or Cantref y Gwaelod retold by T. L. Peacock in "The Misfortunes of Elphin." In this he is almost certainly right in the main, though some of the scraps of evidence quoted are conjectural, and it is doubtful whether enough is allowed, either in this section or in others, for the consolidation, with the lapse of time, of the boulder clay which formed the main part of the lost lowlands. It is rightly stated that there has been distinct loss of land within historic times, but protection at the public expense is difficult, because the public does not appropriate land gained from the sea, and this, in the last thirty-five years, has been more than seven times the land lost. Even on the west coast gains have counterbalanced losses. The reproductions of old maps and prints are a valuable feature of the book.

Has the North Pole been Discovered? By Thomas F. Hall. Pp. 539+maps, charts, etc. (Toronto: Richard G. Badger.) Price 2.50 dollars.

The Peary-Cook question still arouses controversy in the United States, and the author of the book before us, a former captain in the American Merchant Service and a past member of the Nebraska Legislature, has elaborately cross-examined the various narratives by Peary and his colleagues. He concludes that there is no conclusive evidence that either of the two claimants reached the North Pole. He states that he began his investigation with full faith in Peary; if so, his feelings have been so strongly roused that his statement is marked by the appearance of bitter personal bias. He maintains that the speeds claimed by Peary in his last marches are impossible, that Peary's photographs are shown by incompletely obliterated shadows not to have been taken in the latitudes claimed, and that Peary's different narratives are inconsistent and contradicted on essential questions by those of his negro companion, Henson. The author also claims that recent ascents of Mount McKinley show that Cook must have achieved the ascent of that mountain.

Whether the author's criticisms of Peary are fundamental, or based merely on honest errors in the narratives, on inconsistencies due to haste in publication, and on photographs which were prepared as book illustrations, and not as evidence, will doubtless be ultimately settled by the opinion of competent and impartial American geographers.

The Mystery of Life as Interpreted by Science. By R. D. Taylor. Pp. 176. (London and Felling-on-Tyne: The Walter Scott Publishing Co., Ltd., 1919.) Price 3s. 6d. net.

Most readers of Nature seek enlightenment on "The Mystery of Life as Interpreted by Science"; but whether they will find it in the little book which Mr. R. D. Taylor presents under this title is open to question. All life is psychic in its essential being, and every atom is "a psychic" endowed with super-consciousness defined as native cognition, determinative and directive, inbred in the structure of every atomic centre. This super-consciousness is the law of its being. In accordance with this law every atom radiates attractional emanations into the related atom of next lower radial potency, and coincidently receives radiations from the next higher. The "radial-attractional law of gravitation," which is not only the act of tending towards a centre, but is also coincidently the act of developing towards a source (and thus includes all human aspirations), is the theme of a book the metaphysical implications of which call for no further notice here.

Directions for a Practical Course in Chemical Physiology. By Dr. W. Cramer. Fourth edition. Pp. viii+137. (London: Longmans, Green, and Co., 1920.) Price 4s. 6d. net.

In the present edition of this laboratory manual the arrangement and method of treatment adopted in previous editions have been retained, while the subject-matter is also largely the same as that in the edition reviewed in Nature of March 25, 1915. Two additions have been made—a simple experimental arrangement for demonstrating cell-respiration, which was devised by Dr. Drew, is described, and a section has been added on the balance between acids and bases in the organism. In the latter a brief account is given of the elementary facts of the physical chemistry of acids and bases, and simple experiments by which they can be verified are described.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Heredity and Acquired Characters.

IN his letter headed "Heredity" published in NATURE of November 25 Sir Archdall Reid has not done justice to himself or to your readers. He endeavours to gain attention once more for a jocose misrepresentation of the meaning of the term "acquired characters," and in order to do so neglects to mention the fact that in NATURE, vols. lxxxviii. and lxxxix. (1911 and 1912), the matter was very fully treated in letters from himself and others, including two from me (vol. lxxxix., p. 61 and p. 167). It is the simple fact that in those volumes Sir Archdall Reid had his fling in attempting to mystify your readers with a facetious misrepresentation of the proper use of the term "acquired characters." The fictitious nature of the case presented by him was exposed at that time, and he adds nothing to it to-day. It would be sufficient to refer your readers to that correspondence, the mention of which is avoided by Sir Archdall Reid on the present occasion, were it not difficult for many people to obtain the volumes in which it occurs.

I may, therefore, state here that Sir Archdall Reid's joke or trick consists in ignoring the special and definite significance which has been given (originally, I believe, by Wallace) to the term "acquired characters," namely, that of an English equivalent or code-term for Lamarck's words "les changements acquis." He, on the present occasion, as in 1911, deliberately and professedly treats the statements of accredited writers concerning "*acquired characters*" as though they were using those two words in what he calls their "natural sense," and not (as they themselves declare they are using them) in the special Lamarckian sense as a "code-term." He thus creates confusion and mystification. He declares that *every* character which makes its appearance in the course of development from the egg-cell to the end of life is in the natural sense of those words an "acquired character," and he charges writers who maintain that "acquired characters" are not transmissible with making a statement which is "purely nonsensical." "There is," says Sir Archdall Reid, "absolutely no meaning in the Neo-Darwinian statement that acquired characters are not transmissible. It is like a declaration that five miles weigh five pounds." To that the obvious reply is: "If you, without any warrant, alter the established signification given by the Neo-Darwinian to the chief term in his statement, you can, of course, convert it into nonsense, and your proceeding is merely farcical."

Though many readers of NATURE are undoubtedly acquainted with Lamarck's "Philosophie Zoologique" and the careful definition given by him of what he meant by his words "les changements acquis," it is desirable to cite here what Lamarck said, since Sir Archdall Reid, in order to give an air of sincerity to his little joke, poses as an ignoramus, and possibly others really do not bear in mind Lamarck's statements. Sir Archdall Reid says (November 25): "I daresay I am wrong, but I should be glad to learn just how I am wrong." Further, he writes: "If it be thought that I am mistaken as to all this, can anyone tell us in precise terms what in the world the Lamarckian controversy was *about?*" It is difficult to suppose that Sir Archdall Reid has not read his Lamarck, and still more difficult to believe that he has forgotten the letters published in NATURE in 1911 and 1912, where he was plainly told "just how he is wrong," and also what the Lamarckian controversy was, and is, about. In any case, I will now quote what Lamarck wrote about "les changements acquis" and state what the Lamarckian controversy was, and is, about. Lamarck enunciated in his "Philosophie Zoologique" (Martin's edition, vol. i., p. 235) two laws, the first of which postulates the production of departures in shape and structure of the organs of an animal from the shape and structure normal to the species in normal conditions—when the animal is subjected to what were hitherto unusual conditions; whilst the second asserts that the changes thus acquired ("acquired characters" of English writers) are transmitted in generation to offspring. The limitations given by Lamarck's own words must, of course, be carefully observed. Lamarck writes:

"PREMIÈRE LOI.—Dans tout animal qui n'a point dépassé le terme de ses développements, l'emploi plus fréquent et soutenu d'un organe quelconque fortifie peu à peu cet organe, le développe, l'agrandit et lui donne une puissance proportionnée à la durée de cet emploi; tandis que le défaut constant d'usage de tel organe l'affaiblit insensiblement, le détériore, diminue progressivement ses facultés, et finit par le faire disparaître.

"DEUXIÈME LOI.—Tout ce que la nature a fait acquérir ou perdre aux individus par l'influence des circonstances où leur race se trouve depuis longtemps exposée et, par conséquent, par l'emploi prédominant de tel organe, ou par celle d'un défaut constant d'usage de telle partie; elle le conserve par la génération aux nouveaux individus qui en proviennent, pourvu que les changements acquis soient communs aux deux sexes, ou à ceux qui ont produit ces nouveaux individus."

Those are Lamarck's two laws. The first is universally admitted to be a correct statement of observed fact in numerous cases, though it is not to be accepted as formulating a primary or fundamental property of living matter.

The second law—stating that "les changements acquis" (for which words, in the exact sense in which Lamarck used them, the English term "acquired characters" was many years ago adopted and established as an equivalent) are preserved by generation to the new individuals born from the parents which have acquired those changes in accordance with the first law—has been challenged by many naturalists and accepted by others. Lamarck makes it abundantly clear that the characters transmitted to a new generation—with which he is concerned—are *changes* in form and structure acquired by the parents as a result of *more frequent and sustained use* of some organ or of *constant disuse* of such organ resulting from the influence of circumstances to which their race has been for a long time exposed. It would have rendered misapprehension more difficult had the term "acquired changes" been adopted instead of "acquired characters" as the English equivalent of "changements acquis." The distinctive attribute of the acquired characters so indicated and defined is that they are departures (either increase or decrease) from the usual or normal size, form, or structure of this or that part, arising in an organism "which has not yet passed the limit of its [individual] development" when that organism is submitted to novel conditions. They are *novelties* which arise under *novel* conditions, departures from the normal which occur when the environment ceases to be—*in certain important par-*

ticulars—that which is associated with the normal form of the species.

The "Lamarckian controversy" about which Sir Archdall Reid affects to be ignorant was, and is, as to whether the changes of structures set up in the manner indicated in Lamarck's first law are ever transmitted by generation to progeny. It has been demonstrated that such changes do occur, but no satisfactory evidence of their transmission by generation to progeny has been produced. It is admitted that, so far as we know, such a transmission is *possible*, and, in the period at which Lamarck wrote, the assumption that such transmission occurs was a reasonable one. But hitherto all attempts to give convincing demonstration of its occurrence have failed, though such attempts have been, and still are, made by able biologists.

Before concluding this letter, may I direct the attention of readers of NATURE to the correspondence on this subject which was started by Sir Edward Fry in 1894 (vol. li., p. 54), to which I contributed a long statement? Sir Edward, owing to his lack of acquaintance with Lamarck's writings, was genuinely misled by the term "acquired characters," then less familiar than it is to-day. E. RAY LANKESTER.

December 8.

IN NATURE of November 25 there appears a long letter from Sir Archdall Reid on the subject of heredity. In this letter he seeks to show that the whole controversy about the inheritability of acquired characters—perhaps *the* controversy of most vital importance in biology—is a mere "pother" about "words full of sound and fury, signifying nothing." "All the characters of the individual," he assures us, "are innate, acquired, and inheritable in exactly the same sense and degree."

Sir Archdall Reid must have a singularly poor opinion of the intelligence of his co-workers in the field of biology if he thinks that they have wasted, and are still wasting, their time in a meaningless controversy. The list of such "wasters," moreover, must include the honoured name of Darwin himself, who had a very clear idea of what was implied in the term "inheritance of acquired characters," only he termed it the "inheritance of the effects of use and disuse."

The fact is that the whole of Sir Archdall Reid's letter rests on a mere play with words. I recollect reading of a lawyer who, in defending a client on a charge of slander, maintained that "villain" was a perfectly harmless epithet, since logically and etymologically it only signified a servant employed on a farm.

Sir Archdall Reid begins by stating that all characters are acquired in response to external conditions, since there are no characters, but only potentialities, in the formless germ, and these potentialities will not be realised unless conditions are favourable. Did Sir Archdall Reid imagine that this was doubted by any biologist? Is it not, on the contrary, so elementary and self-evident that every biologist, in discussing genetic questions and assuming an irreducible minimum of intelligence in his hearers, takes it for granted?

If, however, Sir Archdall Reid thinks that such an assumption is unjustifiable, let me try to make the issue a little clearer.

The egg of any animal will only develop its innate possibilities as manifested in the features of the adult animal if the surroundings are favourable, but the development results in a definite type. If the surroundings are unfavourable the type may not come to fruition, but there will be an obvious attempt to attain it; the egg of the shrimp, for instance, never shows any tendency to develop into the same form as the egg of a fish. There is, of course, for every egg a particular combination of circumstances which is especially favourable and may be termed the normal environment, and the normal life of the animal and the function of its organs consist in answering the demands made upon it by this environment.

If, now, the environment be altered to such a moderate extent that the animal is still able to respond to it, then the use of certain of the animal's organs and their growth will be altered. On that point all are agreed; the difference between opposing schools of biologists begins when the question is raised as to what will be the characters of the offspring of the altered individual.

The Neo-Darwinian or Weismannian school maintains that the germs produced by the altered animal will be precisely like the germ which gave rise to that animal. If they develop in the normal environment of the species they will give rise to individuals conforming to the normal specific type; if they develop in the same circumstances as their immediate parent they will show similar divergences from the specific type.

The Lamarckian school, on the other hand, contends that the germs of the altered animal *become themselves slightly altered*, so that if they are allowed to develop in the normal specific environment they may still in their earlier stages of growth show a trace of the altered structure of their parent; and, on the other hand, if they are allowed to develop in the same circumstances as their parent they will manifest the altered structure acquired by the parent *more rapidly and in stronger degree than did the parent.*

I have already had occasion to direct the attention of readers of NATURE to the fact that certain experimenters on the Continent claim to have established the truth of these two essential postulates of Lamarckism. This claim may be ill-founded or well-founded—that is a matter for argument—but no reasonable Neo-Darwinian would fail to admit that if the claim proves to be well-founded the Lamarckian position will be established.

Sir Archdall Reid states that, "apart from variation, like exactly begets like when parent and child develop under like conditions." Leaving aside for the moment the quibble about the word "variation," the Lamarckian contention is that like does not "exactly beget like," but that the influence of conditions on the character of the individuals composing a species *is cumulative from generation to generation.* There is a rapidly accumulating body of evidence in favour of this view; for a piece of evidence to which my attention has recently been directed I am indebted to my friend and colleague, Prof. Dendy. It is as follows: The peach in Europe is a deciduous tree. Transplanted to Réunion it has become an evergreen in the lowlands of that island, but has remained deciduous in the highlands. If a seed be taken from the evergreen tree and grown in the highlands it will still in the first generation give rise to an evergreen tree, although its ancestors were undoubtedly deciduous.

Finally, I should like to say that the sense in which I understand the word "variation," and the sense in which I think it is understood by the majority of my co-workers, is a divergence from the normal appearing among the offspring of a normal individual *when the normal environment remains unchanged*, and in that sense it should be used by Sir Archdall Reid. E. W. MACBRIDE.

Imperial College of Science, South Kensington, London, S.W.7, December 8.

The Energy of Cyclones.

IN NATURE for December 2, p. 436, Sir Napier Shaw remarks: "There can be no doubt, I suppose, that solar and terrestrial radiation are ultimately responsible for the kinetic energy of the winds." If we include other possible radiations from space and the effects of high-velocity cosmic matter striking the upper limits of the atmosphere, few will fail to agree. Not many years ago the theory mentioned by Mr. J. R. Cotter (NATURE, November 25, p. 407), "that the energy of a cyclone is derived from the heat-energy of the earth's surface," would have been considered as most probably correct. However, Mr. W. H. Dines, with the aid of about 250 soundings of the upper air with self-registering balloons, proved that the lower central parts of cyclones are actually cooler and denser than the surrounding parts. That his conclusion is of general application so far as western Europe is concerned the daily Upper-Air Temperature Charts issued by the Meteorological Office show.

Fig. 1 shows the distribution of temperature in cyclones found by Mr. W. H. Dines, and in the face of such a distribution it appears to be impossible to attribute their growth and disappearance to the heat-

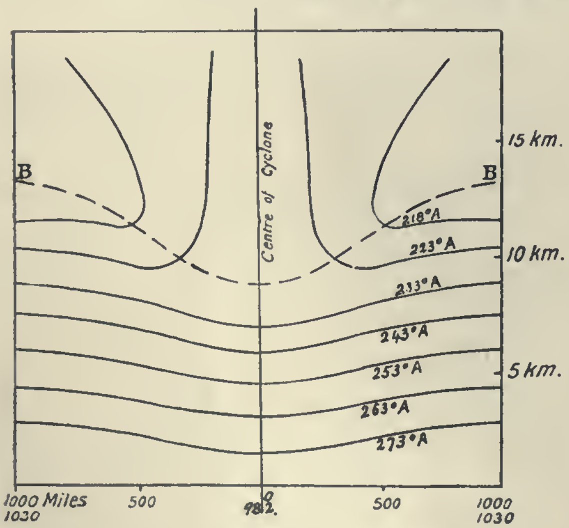

FIG. 1.

ing and cooling of the troposphere. Local heating of the atmosphere near the earth's surface does cause up-rushes of air, resulting in thunderstorms, etc., but they never seem to result in cyclones.

In view of the actually determined distribution of temperature in cyclones being as shown in Fig. 1, I suggested (*Phil. Mag.*, July, 1915, April, 1916, and March, 1918) that the upper, as well as the lower, limits of the atmosphere become irregularly heated, and that the general and local winds of the earth result from the interaction of the movements set up by these two layers of heated air. Referring to Fig. 1, it will be noticed that the line of division BB between the stratosphere and the troposphere is lower at the centre of the cyclone than at its margins, and that the temperature at the centre of the depression is lower than near the margins. So marked is this lowering of temperature that, in spite of the lower pressure, the central air is denser than that surrounding it, and there is, consequently, no tendency for the column of air to rise. On the other hand, above BB the temperature of the stratosphere at the cyclonic centre is higher than it is at the margins at similar levels, and the pressure at the centre being lower as well, there is a strong lifting power exerted upon the troposphere by the stratosphere. So long as such lifting action is in operation the cyclone persists.

With regard to the general circulation upon which the travelling cyclones are superimposed, all the registering balloon ascents yet made indicate that the temperature conditions of the greater cyclonic circulations of the polar areas are similar in nature to those of the smaller ones; nor is there as yet any evidence suggesting that the conditions of decay in cyclones differ in anything but degree from their conditions of growth.

Sir Napier Shaw has pointed out that rain and many other weather conditions are very often due to the "embroidery" of the cyclone rather than to the rising air in the centre of the cyclone itself. The Daily Weather Charts show that, especially near the margins, the effect of the oncoming or growing cyclone, impressing its circulation upon already existing winds, is often to cause damp, warm air-currents to mount over dry ones, and thus to produce rain and cloud. Mr. W. H. Dines (NATURE, November 18, p. 375) may be quite correct, therefore, in holding that cyclones do not result from warm air of the troposphere flowing over cold air near the earth's surface; and Lt.-Col. Gold (*ibid.*, November 11, p. 345) may be equally correct in believing that rain is often due to such conditions obtaining in cyclones. However, such movements are secondary phenomena, and may add some energy to an already existing cyclone, for the reasons given by Sir Oliver Lodge (*ibid.*, November 25, p. 407).

The formation of a cyclone, as Sir Napier Shaw (*ibid.*, December 2, p. 437) states, shows that "the region covered by a cyclone has simply lost a certain part of the air which it normally possesses. In one example I estimated the loss as equivalent to 40,000 cubic km. at sea-level. Beyond all doubt or question air had gone; it was not piled up in anticyclones fore and aft, as we used to think the convected air of our cyclones must be; it was gone clean away." According to my conception, the upper limit of the atmosphere is often heated locally by radiant energy or high-velocity matter from without. Heated protuberances are thus formed at the upper effective limit of the atmosphere. The air of these protuberances then flows away in all directions, leaving cyclonic conditions below the area where the protuberance was formed.

R. M. DEELEY.

Tintagil, Kew Gardens Road, Kew, Surrey, December 4.

Name for the Positive Nucleus.

MAY I ask in what way "the hydrogen nucleus or unit of positive charge," for which Sir Oliver Lodge (NATURE, December 9, p. 467) provides us with a choice of brand-new names, "proton, ambron, merron, uron, prime, centron, and hylon," differs from our very old friend "hydrion," the familiar hydrogen ion of the physical chemist? The point occurred to me when Sir Ernest Rutherford suggested the new name "proton" for it in Section A of the British Association this year. Its new hypothetical *rôle* as "the brick of which all atoms are built up, electrons acting as cement," although probably more acceptable to chemists than the curious inversion of this which afforded to a past generation of physicists such peculiar æsthetic and intellectual gratification, ought not to be allowed to obscure the fact that there is nothing hypothetical or protonic about the particle itself. In 1920 hydrogen ion, as the common constituent of that very common class of substances called acids by the chemist, surely does not need a choice of seven brand-new names. In fact, one Faraday did some very important work indeed in the subject generations before the modern hydrophobic school, with its inveterate aversion to "anything wet," had arisen. FREDERICK SODDY.

The Stereoscopic Appearance of Certain Pictures.

DR. EDRIDGE GREEN'S explanation on p. 375 of NATURE of November 18 does not go quite far enough. It is true that a picture in correct drawing and perspective will be correct only for one eye, but the eye must be situated at a certain point which is geometrically defined by the elementary rules of perspective. A photograph taken by a pin-hole camera or with any good lens is in true perspective. It should be viewed at the same angle as that with which it was taken; in other words, it should be viewed from a distance equal to that of the pin-hole (or a certain point in the lens combination) from the plate.

Photographs and illustrations are generally viewed at too great a distance. With an angle of view of 55° the eye should be at a distance approximately equal to the longest dimension of the picture. If this is considerably less than 250 mm. to 350 mm. (say 10 in. to 14 in.) a lens must be used, not for magnification—which is a disadvantage in the case of coarse-grained process blocks—but to enable the eye to be used at approximately the right position. Exactness is not necessary, as the eye is so easily pleased. An ordinary reading-glass may be used for the illustrated papers, but it must be held close to the eye. The result is sometimes very striking. Photographs of complicated instruments or of complicated machinery in a factory, which are scarcely intelligible when viewed in the ordinary way, stand out almost as solid as with a binocular stereoscope. Partly because photographs, illustrations, and pictures are generally viewed with both eyes, and partly because the distance is usually much too great, accurate perspective representation, as a rule, produces no stereoscopic illusion whatever.

A. P. TROTTER.

Ajaccio, Corsica, December 3.

Luminosity by Attrition.

THE following workshop observations may throw some additional light on luminosity by attrition, the subject of recent correspondence in NATURE:

Blocks of optical glass are cut into slabs by means of a soft steel circular saw, the edge of which is usually charged with diamond-dust, a copious flow of a lubricant such as petrol, paraffin, or soapy water being employed.

Within the block of glass at the line of contact with the saw there is often visible a blue-tinted white light, limited to the acting portion of the edge of the saw. The light is not thrown downwards in the direction of motion, as in the case of a shower of sparks or of an ordinary flame.

The bluish-white light is most apparent when the cutting is forced, when the saw is blunt, and when an insufficient amount of diamond-powder is used. When the saw is working well the light can only be seen with difficulty by excluding extraneous light.

There is no evidence of any temperature cracking over the cut surfaces, and I know of no instance in which the petrol or paraffin has been ignited even when the saw is cutting at the extreme edge of the glass in contact with the air.

When carborundum is used instead of diamond-powder—the carborundum, however, being injected with compressed air and a water lubricant employed—a dull reddish light appears. It is difficult to say if this reddish light is accompanied by any characteristic heat cracks, as the cutting action with carborundum is more complicated, there being a secondary side abrasion at the surfaces of the saw which might obliterate minute heat-cracks.

JAMES WEIR FRENCH.

Anniesland, Glasgow, December 8.

Tragic Death Feint of a Snake.

ON Sunday morning, May 30, about 10 o'clock, I noticed a common western hog-nosed viper, about 20 in. in length, basking on the lawn in the warm sunshine. I approached the serpent in company with a friend to make some investigation of it, and only to interfere with it enough to keep it from crawling away. The creature went through the usual feint of being a dangerous snake that is peculiar to this species, and quickly began to coil and recoil and to hide its head under its body. After it had done this a short time it turned on its back, but continued to writhe as though injured severely. Gradually it assumed a position simulating that of a dead snake lying on its back, with its mouth completely inverted and bleeding. This was done in such a way that the head appeared to be completely mashed or severed. The exudate of blood from the entire surface of the mouth was perfect. It was the most complete and well-carried-out feint of a tragic death that I have ever witnessed, and all without the least torture or stroke of any kind from me. I only detained the snake by placing my foot in front of it and turning it back once at the beginning. We left the creature in this apparently killed condition, only to see that it disappeared in a very short time.

My observation of this genus Heterodon (hog-nosed viper), which is not a viper at all, has shown me that it always puts up the tamest kind of bluff before hiding its head, but never before have I observed this complete performance with a bloody exudate from the inverted mouth. I am convinced that it will not often be carried out thus completely unless the conditions of season, the weather, and the development of the snake are just right. In other words, I think that it must be a peculiarity of some maturity of growth, and that the full vigour of a warm day in late spring or early summer must enter into it.

W. E. BARTLETT.

Belle Plaine, Kansas, U.S.A., November 22.

The Alkaloids of Senecio jacobæa.

IN the Notes in NATURE of November 4, p. 321, reference is made to "*Senecio jacobaea*, the source of the disease in sheep in Nova Scotia." It should read "cattle" instead of "sheep," for although injurious to sheep it has not been fatal to them as it has been to cattle. The "Pictou cattle disease" has in some quarters led to change of the common name "St. James ragwort" to "cattle-kill"—a term analogous to "lamb-kill" for *Kalmia glauca* and *K. angustifolia*, supposed to be poisonous to young sheep.

The alkaloids of *Senecio jacobaea* were, under the auspices of the Nova Scotia Institute of Science, planned to be investigated by the late Dr. Eben MacKay, of the University of Dalhousie, on the chemical side, and by Prof. C. L. Moore on the biological side. A. H. MACKAY.

Education Office, Halifax, Nova Scotia, November 22.

Instruments for the Navigation of Aircraft.

By G. M. B. DOBSON.

THE design of instruments to aid the navigation of aircraft, like all other branches of aeronautics, has been greatly accelerated by the war, though many of the instruments required are only now reaching their final stages of development, and instruments to effect navigation—as distinct from pilotage by the aid of landmarks—were scarcely used during the war.

Before and during the earlier stages of the war the errors of the magnetic compass as used on aeroplanes were the subject of much discussion, and numerous designs were tested with the view of overcoming its defects, which are, unfortunately, really inherent. The gyroscopic turn indicator has now solved this problem by taking over some of the original duties of the compass. Provided the aeroplane be flying straight, the compass shows the direction of flight correctly, but as soon as a turn is started it immediately becomes untrustworthy. It must be remembered that in a cloud the pilot of an aeroplane has no means of knowing whether he is turning to right or left, or flying straight. Thus previously the compass was used both to keep a straight course and to obtain the bearing of that course. The gyroscopic turn indicator—originally due to a suggestion by Prof. J. B. Henderson—is now available in several forms, all of which work well, and enable a pilot to turn and straighten out again while in a cloud almost as easily as in clear air. With the presence of this instrument the compass is required only for showing the direction of flight during the time the aeroplane is flying straight.

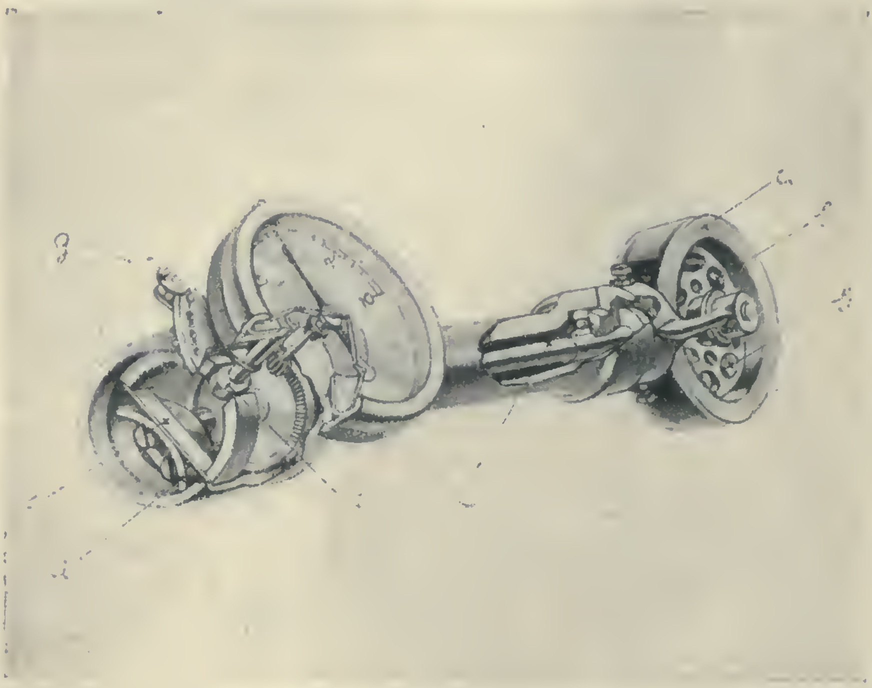

FIG. 1.—R.A.E. gyro turn indicator Mark V. *a*, gyro wheel; *b*, *b*, oblique holes for air-drive; *c*, shaft carrying gyro wheel communicating motion to pointer; *d*, cam on shaft *c*; *e*, controlling spring; *f*, cam altering tension of spring *e*, worked by lever *g*.

The gyroscopic turn indicator depends for its action on the precession of a rotating gyroscope against suitable controlling springs, when its axis of rotation is changed. One simple form is shown in Fig. 1. The gyro wheel seen on the right is

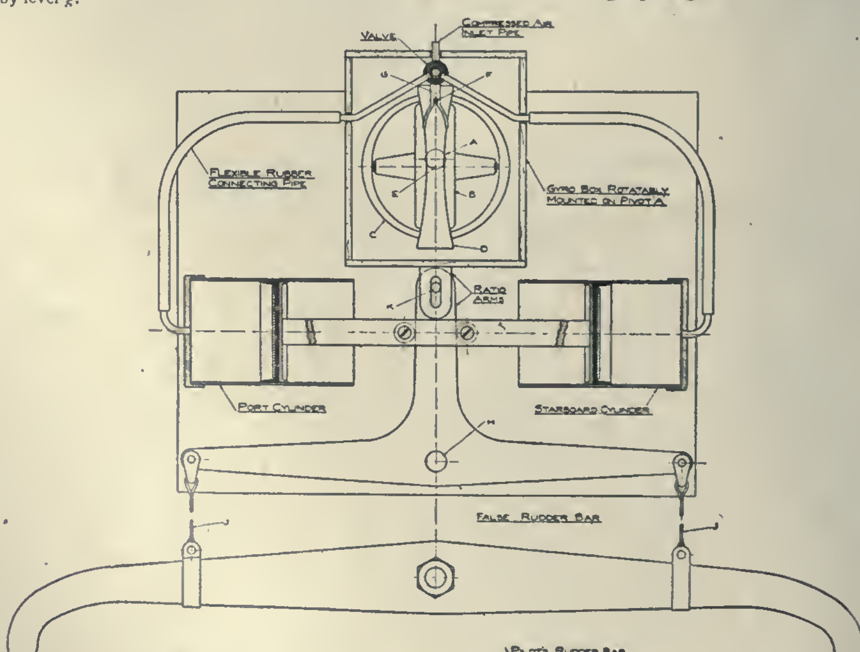

FIG. 2.—Gyro rudder control. B, gyro wheel; C, D, gimbal rings of gyro; F, G, pin and link connecting outer gimbal ring to valve.

mounted outside the aeroplane, and spun at 10,000 to 15,000 revolutions a minute by the relative wind. The central cylindrical portion passes inwards through the side of the aeroplane and carries the dial, which is in front of the pilot. By means of a cam marked *f* the tension of the control spring *e* can be varied at will over a large range, and thus the sensitiveness of the instrument can be changed to suit different machines or different atmospheric conditions.

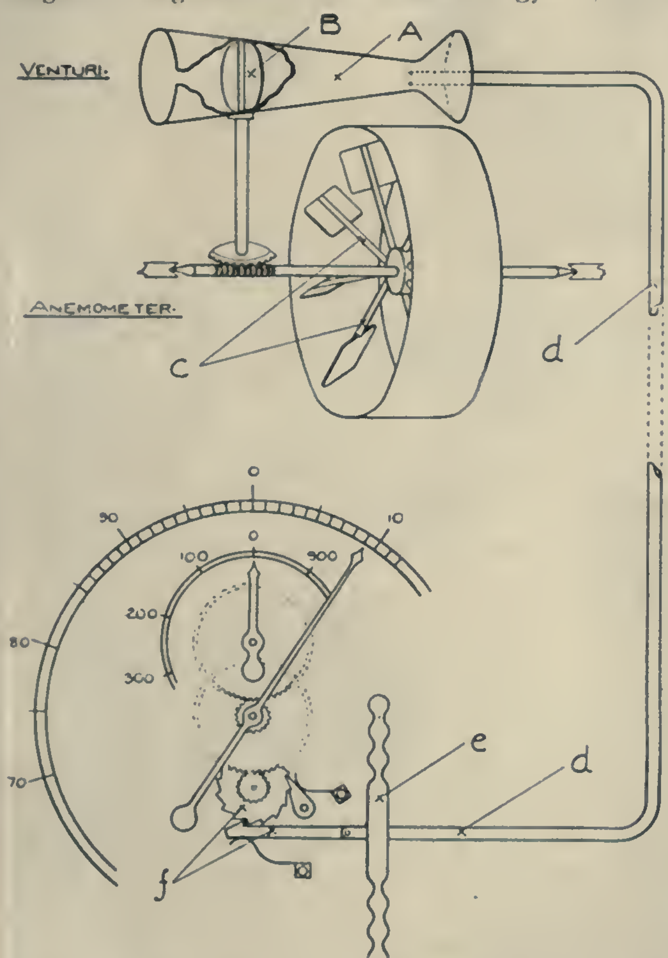

FIG. 3.—R.A.E. pneumatic air log. A, Venturi tube exposed to wind; B, disc in exit cone revolved by wind nill C; *d*, pipe connecting throat of Venturi to diaphragm *e*; *f* ratchet and wheel.

Another gyroscopic instrument which has been designed during and since the war is the gyroscopic rudder control. This is intended to relieve the strain on the pilot during a long flight by controlling the aeroplane's direction. With it the pilot need only check the course once every five to ten minutes. The instrument consists of a gyroscope hung freely in gimbals and carefully balanced. With good workmanship such a gyroscope will keep its direction within a degree in ten minutes. Any movement of the aeroplane relative to the gyroscope immediately operates a valve controlling a pneumatic servomotor, which puts over the rudder so as to turn the aeroplane back to its original course. It is also fitted with a simple "follow-up gear," so that the deflection of the rudder is proportional to the amount the aeroplane is off its true course. The apparatus is shown diagrammatically in Fig. 2. The gyroscopes are about 3 in. in diameter, and spun at about 15,000 revolutions a minute by compressed air.

Until recently the only method of finding the distance an aeroplane had travelled through the air was to note the length of time flown and the average reading of the air-speed indicator. The latter reading, being dependent on the density of the air, must be corrected for the density at the height flown, as well as for a small error due to interference of the air-flow by the neighbouring parts of the aeroplane. To eliminate this trouble, an air log was designed, which should record continuously the actual distance travelled through the air. This is shown diagrammatically in Fig. 3. A windmill type of anemometer is employed, since this has the advantage that it needs no correction for change of density. As the windmill must necessarily be fixed on an exposed part of the aeroplane, it must be made to transmit its indications to the pilot. This is conveniently arranged by mounting a Venturi tube alongside the windmill. The exit of this Venturi tube is alternately opened and closed by a rotating disc, say once every 1000 revolutions of the windmill. The pressure at the throat of the Venturi tube is thus alternately above and below atmospheric pressure, and a pipe led from the Venturi tube to the indicator transmits these alternations of pressure, which operate the counting gear through the agency of a small diaphragm. The addition of a small adjustable baffle behind the windmill allows the interference error to be eliminated once for all for any aeroplane.

The use of ordinary sextants in the air is largely ruled out by the fact that the true horizon is nearly always obscured by haze. The top of this layer of haze is generally nearly horizontal, and has, therefore, sometimes been used instead of the real horizon. As, however, it may occasionally be inclined to the horizontal by a degree or more, such results are untrustworthy.

The use of bubble sextants has been attended by greater success than was at first expected. On aeroplanes the mean of six readings will generally give the altitude of the sun or star correctly within about ten or fifteen minutes of arc. On airships much better accuracy seems possible. The design of bubble sextants for use in the air is largely a matter of making them convenient to use. The image of the sun and bubble must move together across the field if the instrument be tilted, and the size of the bubble must be adjustable. The general principle of a bubble sextant is shown diagrammatically in Fig. 4. By means of a lens and prism (not shown), which are fixed above the bubble lens, the horizon can also be seen in the field of view, as well as the bubble, so that the instrument may be used as an horizon sextant if required.

The problem of the rapid calculation of sextant observations appears to have been solved completely by the cylindrical slide-rule due to Mr. Bygrave. With a slide-rule about 7 in. long results can be obtained in three or four minutes' time which are accurate to within about three minutes of arc. With larger patterns greater accuracy in obtained.

The accompanying illustrations are from a lecture on "The Design of Instruments for the Navigation of Aircraft," read to the Royal Geographical Society by the author on May 10 last, and published in the *Geographical Journal* for November.

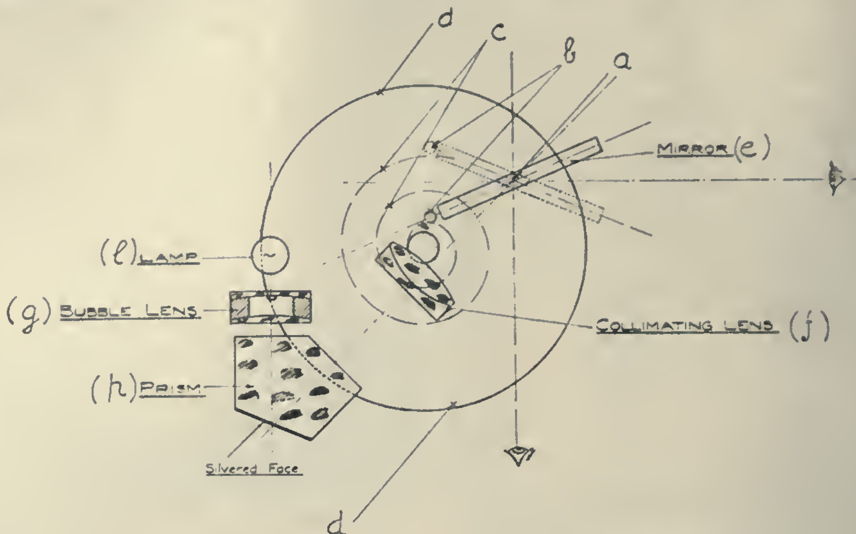

FIG. 4.—R.A.E. bubble sextant Mark II. *a*, axis about which clear mirror *e* is moved by pin *b* resting on cam *c* fixed to drum *d*. Image of bubble in lens cell *g* seen by reflection in *e* through lens *f* after further reflection in prism *p*. Bubble illuminated at night by lamp *l*.

Industrial Research Associations.

VI.—THE GLASS RESEARCH ASSOCIATION.

By EDWARD QUINE.

THE Glass Research Association has been established for investigation into the problems of the glass industry in accordance with the scheme of the Committee of the Privy Council for Scientific and Industrial Research. The association received its Certificate of Incorporation on August 11, 1919, and held the first general meeting on October 14 following.

The objects of the association are to conduct scientific and technical investigations relating to glass and its manufacture, and to disseminate among members technical and other information bearing on these subjects and on the production of articles made wholly or partly of glass.

The rate of development of the glass industry in this country is largely influenced by difficulties in the matter of technique, works organisation, production and equipment, and, in order that the industry may attain a high degree of efficiency, it is necessary for investigations to be directed towards overcoming these difficulties, in addition to investigations of fundamental principles and search for new knowledge. To ensure that greater economy in production and more satisfactory products may be obtained, improved methods must be introduced, and the works practice of the industry brought into line with the advanced methods found operative in other countries. Until recent years no comprehensive research work relating to the industry had been carried out in this country, but the need for a deeper and more extensive knowledge of the fundamental facts underlying the various processes of manufacture is now appreciated. The association is consequently endeavouring to secure that the fundamental principles and their application shall be thoroughly investigated by systematically conducted researches, so that, side by side with the modernising of works practice, and the introduction into the industry of the scientific control of the various operations, new knowledge may be acquired which may ultimately lead to industrially valuable developments.

The investigations of the association cover the problems of all sections of the glass industry other than those of optical glass, research work in which is being undertaken by the British Scientific Instrument Research Association.

The membership of the association is limited to British corporations and British subjects carrying on business in connection with the manufacture of glass, and other trades and industries allied therewith or accessory thereto. Individuals ineligible for membership or not desiring admission as members, who are interested in the glass industry and willing to subscribe to the objects of the association, may be admitted by the council as associates. At present there are 135 members and seventeen associates.

The management of the association is vested in the council with an executive committee; the council consists of a majority of elected members together with a limited number of members co-opted because of their special knowledge and experience, and members nominated by the Department of Scientific and Industrial Research. The chairman of the first council is Mr. George E. Alexander, whose support and direction have been largely responsible for the successful establishment of the association.

The organisation and direction of research work is entrusted to a director of research, and the association has appointed to this post Mr. R. L. Frink, formerly of the Frink Laboratories, Lancaster, Ohio, U.S.A., who took office on March 1, 1920.

The director of research works in close consultation with seven research committees, which have been appointed by the council to survey the field of research in relation to glass and the glass industry. The terms of reference of these committees are:—

(1) Chemical and physical properties of glass (at all temperatures). (Chairman: Dr. W. Rosenhain.)

(2) Fuels, refractories, furnaces. (Chairman: Mr. S. N. Jenkinson.)

(3) Glass-making materials, glass-founding—temperature measurement and control; annealing and finishing other than decorative and marking operations. (Chairman: Mr. C. C. Paterson.)

(4) Glassware-forming operations—hand and mechanical; glassware-making machinery. (Chairman: Mr. J. Forster.)

(5) Lamp-working. (Chairman: Mr. F. Cossor.)

(6) Design, lay-out, and equipment of glass factories. (Chairman: Mr. R. S. Biram.)

(7) Glass decorative and marking operations. (Chairman: Mr. E. J. Purser.)

The programme of research covers a wide range of subjects, including investigations into the following problems:—

(1) The dependence of fusibility, range of viscosity, colour transparency, brilliancy, refractivity, heat conductivity, expansibility, electrical conductivity, tensile and crushing strength, hardness, brittleness, elasticity, working properties in the blow-pipe flame, resistance to chemical action, and devitrification upon the chemical composition of the glass.

(2) The examination and treatment of clays and bricks, the composition and methods of manufacture of refractory materials, the firing of pots, and investigations in regard to refractory materials.

(3) The design, construction, and operation of furnaces, tanks, pot arches, lehrs, kilns, glory-holes, etc.

(4) The relative value and efficiency of coal, coke, oils, tar, and other combustible mixtures, gas and gas-producers for various types of furnaces and lehrs, and the investigation of electrical methods of heating.

(5) The most suitable raw materials by means of which to introduce certain chemical elements in the best and most economical forms.

(6) Methods of batch mixing.

(7) Measurement and control of temperature during founding, chemical and physical changes during founding, determination of most suitable rates of charging and founding different types of glass, effect of furnace gases upon the various types of glass during founding; methods of aiding the fining process.

(8) Examination and improvement of the methods and conditions under which molten glass can be conveyed to the forming apparatus; moulds and their treatment; mechanical processes of forming glass.

(9) Investigation of annealing temperatures, rates of annealing, effect of annealing on physical and chemical properties; methods of detecting and measuring strain.

(10) Cracking off, grinding, etching, enamelling, decorating, graduating and marking, lamp-working machinery, and other mechanical processes of finishing.

(11) Ventilation of works.

(12) Efficiency and health of operators as related to industrial operations.

Apart from the general problems of the industry, members of the association may, on terms to be decided by the council, have special information given to them by the director or staff of the association, or may have special investigations or researches made for them.

In March, 1920, the association secured the lease of 50 Bedford Square, W.C.1, and these premises have been equipped as offices and laboratories, in which eight research assistants are carrying out intra-mural investigations. Difficulties have been met with regard to the equipment of these premises, thus causing much delay in the work; but now the required equipment is being rapidly assembled.

The full activities of the association have as yet been of short duration, but during this period it has consummated agreements and arrangements with certain of its members whereby it has been made possible to construct an experimental tank furnace for the development of certain types of glasses, and a method of their formation into chemical, table, lighting, and other classes of ware, which, it is hoped, will effect not only a great economy in cost of manufacture, but also increase the production. The construction of a new type of lehr is also contemplated under a similar arrangement, and it is hoped that the results of this work will assist in solving, or even solve completely, many of the technical problems in the annealing of various classes of ware at a greatly reduced cost in construction and operation, and at the same time place annealing under more scientific and positive control. Moulds for forming glassware, their composition, construction, and methods of use are being studied, and the results will shortly be experimentally applied in the works of members.

A number of improvements and inventions, for some of which applications have been made for patents, are being completed, and will in due course be placed in operation. These improvements and inventions include a method of cooling tank-furnace walls, an instrument for indicating and recording viscosity of glasses under practical working conditions, temperature-control apparatus, furnace-controlling instruments, paste for moulds, etching and acid polishing solutions, instruments for classification of colour values of glasses, and others of minor importance.

It has been the policy of the association so far as possible to utilise existing facilities in scientific institutions, and in accordance with this policy the National Physical Laboratory is proceeding with researches on behalf of the association, and it is contemplated that during the coming year the volume of researches at this institution will be considerably increased. Investigations are also proceeding at the Department of Glass Technology, University of Sheffield. Negotiations are pro-pressing with universities and institutions which are specially equipped and adapted to investigate specific problems on behalf of the association.

The association is completing a working agreement with the British Refractories Research Association whereby large-scale researches into the fundamental principles underlying the manufacture of refractories for the glass industry and their industrial application will be carried out by the British Refractories Research Association working in consultation with a joint committee formed of members of both associations and the Directors of Research.

Working arrangements have been made with the British Scientific Instrument Research Association whereby problems common to both associations will be investigated jointly, this association co-operating with the British Scientific Instrument Research Association to the fullest possible extent.

The council has considered the advisability of conducting research investigations into psychological and physiological problems affecting organisation and productive operations of the industry, and, believing that such investigations will be of great benefit both to the operatives and to the manufacturers, has referred this matter to the appropriate research committee for action.

Apart from work to be undertaken by associations and scientific institutions and at factories of members on behalf of the association, arrangements have been made for men of science who have specialised in certain branches of scientific investigation as applied to this industry to undertake researches.

Extensive investigations on "The Bloom and Dimming Effect upon Lamp-working Glass" have been made on behalf of the association by Mr. J. H. Gardiner. A first report has been received which has led to fruitful suggestions for further investigations, which are proceeding. A valuable contribution has been made to the association by Messrs. F. Twyman and A. J. Dalladay upon "Methods of Differentiating Cords in Glass," and further work is being done on this subject in the laboratories of the association.

A vast amount of work lies before the association, and, while realising the limitations of universities in their relation to industrial research and appreciating their services to industry in furnishing both ideas and trained investigators, the council is, in its endeavours to solve such of those problems of the glass industry as lend themselves to investigations along academic lines, anxious for the close co-operation of those universities and scientific institutions having equipment and facilities available, and it is hoped that as its work progresses the association may become the centre of scientific and industrial research into problems of the glass industry for the Empire.

The Quantum Theory.

PROF. MAX PLANCK was awarded the Nobel prize for physics this year, and his address [1] on the occasion of receiving it makes extraordinarily interesting reading. He describes in some detail the way in which he was led to the discovery of the quantum, and to anyone engaged in research the description will be very encouraging, for it shows through what darkness the mind of a great discoverer must grope, and what false tracks he will follow, before he sees the light of the truth. At the time of his discovery few physicists would seem to have appreciated the fundamental importance of the unknown relation connecting the energy of radiation with its wave-length and temperature, perhaps because this relation can be obtained only by a denial of some of the chief articles of their scientific creed. Thus the late Lord Rayleigh had already stated correctly the radiation formula as it ought to be—and as it is for the longer wave-lengths; but he does not appear to have attempted to explain its hopeless failure in the region of the visible spectrum and beyond. The rival formula was that of Wien, far less sound theoretically, but giving good agreement with observation in the visible spectrum.

Planck started on Kirchhoff's idea that if he could find the emission and absorption for a single ideal radiating substance, the true radiation formula would result. He naturally worked on dynamical principles, and inevitably got a result equivalent to no result at all, for it led to the

[1] "Die Entstehung und bisherige Entwicklung der Quantentheorie." Von Max Planck. Pp. 32. (Leipzig: J. A. Barth, 1920.) Price 4 marks.

impossibilities of Rayleigh's formula. He next turned his attention to the thermodynamical aspect, and this illustrates at its best the groping process, for in fact thermodynamics does not contain the answer at all; and yet this track guided him to the right solution. He was led to study a certain thermodynamic function (the reciprocal of the second differential of the entropy with regard to the energy!), and was struck by the fact that, with Wien's formula, it was proportional to the energy itself—a fact that is really quite accidental. For Rayleigh's formula it was proportional to the square of the energy, and Planck was happily inspired to combine the two forms into one. The result gave him the true formula. It remained to find a theory to account for it.

In the course of his efforts to get this theory, Planck turned to the deeper meaning that is attributed to entropy on the kinetic theory, which connects it with probability, and once this was tried it gave the result more simply than might be expected. For in considerations of probability one is bound to work with discrete quantities, and not with continuous; and so one must adopt the idea of atoms of energy for the calculations, though with the ultimate intention of making them infinitely small. But this intention is frustrated, because the formula is obtained without going to the limit at all. This was how Planck arrived at his theoretical explanation of the radiation formula, and by comparison with experiment he was enabled to deduce two universal constants. From the first were obtained the earliest really good values for the charge of the electron and the associated constants. The second, he confesses, perplexed him a good deal, and indeed it would have been surprising if it had not. It was the quantum.

The remainder of the address is occupied with the later history of the quantum, and it is scarcely too much to say that this is simply the history of modern physics. Of all its applications, photoelectric effect, specific heats of solids at low temperatures, specific heats of gases, etc., he not unnaturally gives pride of place to Bohr's spectrum theory. The address concludes with some speculations as to what may be the solution of the almost impossible difficulties with which we are faced. The success of the quantum theory has been, and continues to be, so enormous that it often appears as if writers had forgotten that the whole present system of physics is based on a perfectly definite set of mutually contradictory axioms. So it is particularly interesting to hear some views on this question by one of the great authorities. Unfortunately, Planck does not seem nearer the solution than are the rest of us, for in one place he throws out the discouraging suggestion that the quantum theory is now in the state in which Römer left the theory of light, so that we may expect to have to wait a long time for the Maxwell of the subject to appear and reconcile the seemingly irreconcilable.

Obituary.

SPENCER PICKERING, F.R.S.

BY the death of Percival Spencer Umfreville Pickering at Harpenden on December 5 English science loses one of its most original and attractive personalities. His death was not unexpected; for more than a year his friends had known that Pickering was in a precarious condition, holding on to life by little more than his courage.

Pickering was born in 1858 of good family, and educated at Eton and Balliol. His earliest paper was published while still an undergraduate, and it is not uncharacteristic that it was polemical, directed against one of his dons, and concerned with a basic compound. But his real activity began with his appointment as professor of chemistry at Bedford College in 1881. He began to work upon the constitution of double and basic salts, and passed on to determinations of thermal phenomena accompanying the formation and solution of salts. Naturally enough, this work led to a general consideration of the process of solution, especially as it was about this time that the Van't Hoff theory of osmotic pressure and the dissociation into ions of salts in aqueous solutions was beginning to revolutionise the conceptions of chemists. Pickering would have none of this theory; his work lay at the other end of the scale among strong solutions and powerful electrolytes, and he saw solution as a process of association with formation of hydrates. In a voluminous paper published by the Chemical Society in 1889 he examined with an extraordinary wealth of detail the density, conductivity, heat of dissolution, heat capacity, and expansion of mixtures of sulphuric acid and water, demonstrated breaks of continuity in the graphs representing these properties, and isolated definite hydrates to match the breaks.

Controversy with the supporters of the ionic hypothesis grew intense, for Pickering was turning out an enormous volume of experimental work, and was standing for his hydrate theory almost *Athanasius contra mundum*. Between 1889 and 1896 he printed no fewer than fifty-six papers on solution with the Chemical Society alone, many of them of great length, and involving a vast number of exact determinations, all of which were done single-handed and without assistants. The tide was, however, running against Pickering; he and Ostwald were looking at different sides of the shield; but, though Pickering's work has since fallen into its proper place, at the time it lacked that pragmatic justification of leading to discovery which made the dissociation hypothesis so generally acceptable to the chemists of the day. In disgust Pickering forsook chemistry, the rapid flow of papers ending abruptly in 1896.

Pickering, however, as a younger man had, in order to regain his health, put himself to work as a labourer on the Experimental Farm at Rothamsted, and thus acquired an interest in the application of science to the problems of the cultivator. He had as early as 1894 designed a series of experiments upon the growth of fruit, and had persuaded the Duke of Bedford to set up a trial garden at Ridgemount in Bedfordshire. Results soon began to appear and to arouse dissent; not easily did the practical fruit grower, accustomed to old grass orchards, accept the doctrine of the injurious effect of grass upon tree growth. This subject occupied Pickering to the end of his days; the complexity of the problem grew with extended knowledge; but Pickering maintained his first explanation that the grass roots excrete something specifically poisonous to fruit trees. Much other ground was broken—the effects of pruning, methods of planting and preparing the soil for planting, manuring, insecticides—there is no part of the fruit grower's routine on which Pickering did not inaugurate investigation.

The conclusions published from year to year and gathered together into a final volume, "Science and Fruit Growing," in 1919, have been the occasion of much controversy. The unsuitability of soil and situation, and some defects in management in the early years, hindered their acceptance, but the Woburn trials will remain as the most substantial contribution of the last hundred years to the study of fruit-tree development, one full of stimulus to new workers. His work on spray fluids led Pickering back to chemistry and his earliest interests—basic salts; after a ten years' silence papers began to reappear on such questions as the basic copper salts of Bordeaux mixture, on emulsions (with his strange discovery of a method of solidifying paraffin), and on quadrivalent copper salts.

In his horticulture, as in his chemistry, Pickering was essentially the amateur of genius; he often seemed to be careless of, and even but moderately equipped with, the knowledge that was common form, academic or practical. But he had a disconcerting habit of making discoveries which contradicted that common form. Either from policy or from temperament, he never disguised these antagonisms; where another man might have looked round to find hints and anticipations in previous experience, Pickering would say roundly, "All men who have hitherto expressed opinions on this point have been entirely wrong," even in such a matter as the way to plant a fruit tree. He loved truth, and he pursued it all his life like an artist, for the interest it had to himself; there was also something of the artist's disdain in the way he presented it to the world.

Never in robust health, an accident that deprived him of the sight of an eye probably helped to keep him out of general society, nor had he any of the ordinary man's amusements. At one time he used to walk a great deal with his inseparable companion, his wife, but he seemed to get most pleasure out of the company of a few friends in his Harpenden garden, and it is there, among his fruit trees, or indoors at his piano, that one will remember Spencer Pickering, handsome, imperturbable, a fine and rare presence among men.

A. D. H.

WILLIAM ARTHUR HAWARD.

WILLIAM ARTHUR HAWARD, who accidentally met his death on Monday, December 6, whilst making some final experiments in an important investigation upon gaseous combustion under high initial pressures, upon which he had been engaged during the past two years as a Salters' research fellow in the Imperial College of Science and Technology, was passionately devoted to the cause of scientific research. There is every reason to believe that, had his career not been thus so tragically cut short, he would at no distant date have achieved great distinction as a scientific discoverer. Even during the research which he was completing at the time of his death he had, by most skilful experimental work, discovered a series of facts which pointed to an important new fundamental development in the science of combustion. Indeed, the actual experiment upon which he was engaged when the accident occurred was intended to test a new theory which had been suggested to account for some of his remarkable experimental results. In due course, when the results of his research are published, the importance of them to science will at once be apparent. He undoubtedly laid down his life in the cause of science.

The various stages in Haward's all too brief, but very distinguished, career were as follows: Entering the Royal College of Science in October, 1912, he took the associateship two years later, and also his London B.Sc. degree with first-class honours in chemistry. He thereupon commenced a course of post-graduate study and research in the department of chemical technology, under the direction of Prof. W. A. Bone. It was soon apparent that he was unusually gifted as an experimentalist, for he made some remarkable experiments upon certain aspects of surface combustion, which have yet to be published. During two of his summer vacations, in the years 1915 and 1916, he made investigations under the direction of Dr. R. V. Wheeler at the Eskmeals Home Office Experimental Station upon (1) the propagation of flame in mixtures of hydrogen and air, and (2) the uniform movement of flame in mixtures of acetylene and air, the results of which were embodied in two papers that were published in the joint names of himself and two others (who had assisted him) in the Trans. Chem. Soc. for 1916 and 1917.

In June, 1916, Haward was elected to a Beit research fellowship tenable at the Imperial College; but this was relinquished some six months later in order to join the chemical staff of H.M. Explosives Factory, Gretna, where he remained until shortly after the armistice. He then obtained a Salters' research fellowship, with which, at his own desire, he undertook the particular investigation which he was completing at the time of his death. Though a man of gentle disposition, and very modest in his demeanour, Haward undoubtedly was conscious in the right way of his experimental powers, which excited the daily admiration of those whose privilege it was to watch their rapid development. He had in a marked degree the instinct of the true artist, which was never satisfied with anything less than the best. He was twenty-six years of age, and was married only fifteen months ago.

ANOTHER Kew veteran has passed away in the person of JOHN READER JACKSON, who died on October 28 at his house at Lympstone, near Exmouth, Devon, aged eighty-three. Mr. Jackson was born in 1837 at Knightsbridge, but his family removed about 1843 to Canterbury, where he received his early education, returning in 1851 to school in London. Through the influence of Prof. Thomas Bell, then president of the Linnean Society of London, he was given charge of the museums at Kew, then in process of development under Sir William Hooker, and for nearly twenty years he discharged his duties single-handed, until in 1879 he received the help of an assistant. His work left him but little time for literary diversion, but we owe to him not a few contributions in applied botany in various journals, as in those of the Linnean and Pharmaceutical Societies, the *Technologist*, *Gardeners' Chronicle*, and the like. Mr. Jackson brought out a new edition of Barton and Castle's "British Flora Medica" in 1877, and in 1890 appeared his excellent "Commercial Botany of the Nineteenth Century." He was elected an associate of the Linnean Society in 1868, and was the senior on the list at the time of his death.

WE regret to record the death of DR. CHARLES INFROIT, late head of the radiological service at the Salpêtrière Hospital, Paris. The death of Dr. Infroit adds one more to the list of victims to X-ray dermatitis. A pioneer in the subject of X-rays in medicine, he was injured through over-exposure to the rays at a time when these dangers were not fully appreciated. Despite the disabilities by which he was handicapped, he made numerous contributions to the literature of the subject of radiology, especially from the diagnostic side. So recently as last year a paper appeared by him on the subject of concretions in the lung simulating the presence of a foreign body. A joint communication with Pascalis upon the surgery of the bones of the head appeared in the *Journal de Chirurgie*, 1912. Dr. Infroit designed and put into use a localiser of foreign bodies, which was used very considerably during the war; details of this instrument and the results obtained by its use may be found in the *Bulletin de l'Académie de Médecine*, 1915.

NEWS has just been received of the death of HOFRAT ALEXIUS MEINONG, on November 27, after a short illness, at the age of sixty-seven. Professor of philosophy at the University of Graz, to which he was appointed in 1889, Meinong was well known to philosophical students throughout the world by his important contributions to a special branch of study which he named "Gegenstandstheorie." His earliest published work was "Hume Studien," 2 vols., 1877. His principal work, and that by which he is best known, is entitled "Ueber Annahmen," published in 1902, and a second edition of which appeared in 1910.

WE regret to announce the death, on December 13, at seventy-two years of age, of DR. ALEXANDER MUIRHEAD, F.R.S.

Notes.

THE position of scientific men employed in the Government service has long exercised the minds of scientific workers. The responsibility for the National Physical Laboratory and for the Geological Survey has been handed over to the Department of Scientific and Industrial Research. Kew is still under the Ministry of Agriculture and Fisheries. The Government Chemical Laboratory and the British Museum, with its Natural History Branch at South Kensington, remain distinct institutions for which the Treasury is responsible. All these institutions are largely concerned with the preservation and routine examination of specimens, testing, and the standardisation of methods, and do not serve solely for research. The Ministry of Agriculture has farmed out its research work to institutions such as Rothamsted, the Imperial College of Science and Technology, Cambridge and Oxford, etc.; it still retains, however, on its fisheries side a Research Division. Dissatisfaction has long been felt at the positions, rates of pay, and prospects of promotion in all these offices. Scientific men claim that the positions offered to them should be at least equal in rank, in prospects, and in pay to those offered in the regular Civil Service. The matter came up for discussion at the meetings of several Sections of the British Association at Cardiff. It was referred to the council of the Association, which has now unanimously passed the following resolution and forwarded it to the First Lord of the Treasury:—"That the council considers that no scheme of payment of professional scientific men in the service of the State is satisfactory which places them on a lower level than that of the higher grade of the Civil Service." It is clear that the Treasury must agree with this resolution if the services of scientific men of the first grade are to be obtained for research purposes.

IN addition to revolutionising the methods of wireless telegraphy and rendering possible the practical development of wireless telephony, the thermionic valve promises to have a far-reaching effect on long-distance line telephony in furnishing a telephonic relay of remarkable powers. On long lines considerable difficulties are caused by attenuation of the current-waves and distortion of their form in transmission. Sufficient audibility could be obtained only by going to commercially impracticable expense in the provision of copper in the line, and sufficiently true reproduction of the wave-form for recognisable speech could be reached only by loading the line with artificial inductance to counteract its natural capacity. It is true that various forms of telephone relay have been experimented with from time to time in the endeavour to diminish the amplitude of the current-waves necessary to an extent which would bring the cost of copper within reasonable limits, and at the same time to lessen the troubles due to distortion, but until the advent of the thermionic valve no instrument was found which combined the requisite ratio of amplification with truthfulness of reproduction. A set of thermionic telephone repeaters working on an artificial cable circuit is being demonstrated at the office of the Western Electric Co. at 62 Finsbury Pavement, E.C.2, which represents the state of development arrived at by this company in conjunction with the American Telegraph and Telephone Co. It is interesting to notice in the next column of the *Times* to that in which appears the announcement of this demonstration an account of another example of the use of the thermionic valve in a wireless telephone demonstration between Geneva and London organised by the Marconi Co.

THE following are the lecture arrangements at the Royal Institution before Easter of next year:—Prof. J. Arthur Thomson, a course of lectures on The Haunts of Life, adapted to a juvenile auditory, to begin on December 30; Sir Gerald P. Lenox-Conyngham, two lectures on The Progress of Geodesy in India; Sir James G. Frazer, three lectures on Roman Life (Time of Pliny the Younger), London Life (Time of Addison), and Rural English Life (Time of Cowper); Dr. Arthur Keith, four lectures on Darwin's Theory of Man's Origin; Dr. W. A. Herdman, three lectures on Oceanography; Mr. F. Balfour Browne, two lectures on Mason Bees and Wasps; Dr. G. C. Simpson, two lectures on The Meteorology of the Antarctic; Dr. Percy C. Buck, three lectures on The Madrigal, with musical illustrations by the English Musical Singers; Prof. A. Fowler, three lectures on Spectroscopy; and Sir Ernest Rutherford, three lectures on Electricity and Matter. The Friday evening meetings will commence on January 21, when Sir James Dewar will deliver a discourse on Cloudland Studies. Succeeding discourses will probably be given by Sir Frank Benson, Dr. A. D. Waller, Dr. F. W. Aston, Mr. Solomon J. Solomon, Dr. John Buchan, and Sir Frederick Bridge, among others.

THE meeting of the American Ornithologists' Union in Washington, D.C., on November 8–11, was one of the largest in the history of the union. The election of officers for 1921 resulted as follows:—*President:* Dr. Witmer Stone, Philadelphia. *Vice-Presidents:* Dr. G. B. Grinnell and Dr. J. Dwight, New York. *Secretary:* Dr. T. S. Palmer, 1939 Biltmore Street, Washington, D.C. *Treasurer:* Mr. W. L. McAtee, Biological Survey, Washington, D.C. The single vacancy in the council was filled by the selection of Dr. W. H. Osgood, of Chicago. The programme of nearly forty papers, five of which were illustrated by motion pictures, covered a wide range of subjects relating to North American birds, and also included papers on the birds of Argentina, Nicaragua, Peru, Europe, and Madagascar. In connection with the meeting an exhibition of drawings, paintings, and photographs of birds by American artists, supplemented by a series of prints showing the development of zoological illustration as applied to birds from the earliest times down to date, was arranged in the division of prints in the Library of Congress.

IN the House of Commons on December 8 Sir Philip Magnus asked the Prime Minister:—"Whether, having regard to the urgent necessity of securing for laboratory and other purposes a sufficient supply of the different kinds of glass used in the manufacture of optical and other instruments, and having regard to the importance of encouraging the production in this country of such glass, he will arrange for the introduction at an early date of a Bill prohibiting for a time, except under special licence, the importation of such varieties of glass and of such scientific instruments as may or can be produced in this country?" Sir Philip Lloyd-Greame, who replied, said that the President of the Board of Trade had stated during the debate on December 7 that the Government intends to introduce the Bill dealing with key industries, other than the dye industry, as the first measure next session.

THE four hundredth anniversary of the discovery of the Straits of Magellan is to be celebrated this month. According to the *Scientific Monthly* for November the festivities will centre in Santiago and Punta Arenas, where the occasion will be marked by the inauguration of several important public works, including port improvements, lighthouses in Smith Channel, and the laying of the foundation-stone of the University of Punta Arenas. Great Britain, Spain, Portugal, and the nations of America are to be invited to join Chile in the commemoration of the anniversary.

THE *Times* of December 15 publishes a communication from its Paris correspondent describing a paper read before the French Academy of Sciences on the use of X-rays for the examination of old paintings, and the message refers to a picture by an old Dutch master in which a woman had been painted in over the picture of a monk. There is, however, nothing new in the report given in the *Times*, and this particular application of X-rays was described and illustrated in NATURE of February 26 last (vol. civ., p. 699).

IN a letter published in NATURE of September 30 Mr. C. S. Garnett gave an account of some interesting mineral deposits which had been investigated by him in Derbyshire. It is now announced that three miles south of Matlock, near Wirksworth, Mr. Garnett has discovered a new deposit of fluorspar which is reported to be a mile in extent and 30 ft. in thickness.

THE thirty-third annual Report of the Bureau of American Ethnology for 1911–12, published in 1919, shows no evidence of the effects caused by the war on many scientific societies in Europe. The activities of American anthropologists continue unabated, and the format of the report, with its abundant illustrations, is fully up to the pre-war standard. One of the most important investigations carried on by the Bureau is the transcript by Mr. F. W. Hodge, the Ethnologist-in-Charge, of a series of inscriptions recorded by the early Spanish explorers on El Morro, or Inscription Rock, in the Zuni district, which have an important bearing on the early history of the Pueblo tribes. Opportunity was taken to explore an interesting Pueblo site in the Jemez Valley. It was the custom of the inhabitants to throw large stones into the graves of the dead, thus destroying the pottery deposited with the remains. Numerous fragments discovered will enable these jars to be reconstructed. It is satisfactory to learn that the progress made by Mr. W. H. Holmes in compiling his "Handbook of Archæology" has been satisfactory.

THE *Museums Journal*, recently compelled to double its price, has managed to set against this an increase in the number of pages and plates and the enlistment of high authorities in its staff of reviewers. The improvement seems particularly marked in the domains of art, archæology, and cultural anthropology. The educational use of museums has been much discussed of late by the Museums Association, and the December issue of the journal contains an article, "The Child and the Mummy," by Mr. Peart, Director of Education for the City of Winchester, who suggests ways in which the dead objects in a museum may be made more alive for younger pupils. He would permit some handling, would add colour to backgrounds and labels, would connect the demonstration with knowledge already possessed by the child, and would lay stress on the human associations of each specimen—the romance of collecting and so forth. In the same issue Mr. Charlton Deas pleads for "an Imperial Department of Illustrated Public Information"—the home propaganda of war-time continued in peace.

THE report on the Government Museum at Madras for 1919–20 has just been received. The new superintendent, Dr. F. H. Gravely, announces a large number of additions to the archæological collections, chiefly in the form of copper-plate grants. Among these the most interesting is a set of thirty-one found in an underground chamber at the temple of Tiruvēlāngādu, Chittoor district, and recording the grant to that temple of the village of Palaiyanūr by King Rājēndra-Chōla in A.D. 1016. A sword-fish, *Histiophorus brevirostris*, 5 ft. 1 in. in length, has lately been procured. The specimen 4 ft. 4 in. long mentioned by F. Day ("Fauna of British India," Fishes, vol. ii., p. 133) has disappeared from the museum, and it would be interesting to know where it now is.

THE Wistar Institute of Anatomy and Biology (36th Street and Woodland Avenue, Philadelphia) issues abstract library cards, of standard size for card-catalogues, of all papers appearing in the *Journal of Morphology*, the *Journal of Experimental Zoology*, the *American Journal of Physical Anthropology*, and the six other periodicals which it publishes. Since the abstracts are distributed to subscribers before the appearance of the complete papers, they serve for preliminary notices as well as for permanent records. Individual investigators may find them useful, and societies compiling bibliographies in these sciences would save themselves trouble and expense by taking the complete series.

THE *Meteorological Magazine* for November states that forecasts can be obtained by communication with the Meteorological Office by telegraph or telephone to cover a period of twenty-four hours, also the state of the weather in various parts of the United Kingdom or the Continent. The Office is open day and night, including Sundays. The discussions of recent work of foreign meteorologists held at the Meteorological Office, South Kensington, which take place fortnightly during the winter months, and have continued since 1905, are now noticed in the magazine, and, indeed, for the first time in the public Press. The opening discussion this season was on "New Methods of Forecasting," based on two papers by Prof. Bjerknes. A record of 35,030 metres (22 miles) was alleged to have been established by a balloon at Pavia on December 7, 1911, but doubt is now thrown on the results, and it is suggested that the barograph was not working properly, which renders it probable that the greatest height attained was 18,900 metres—little more than one-half of the alleged height.

A NEW geographical journal has appeared in Italy. *L'Universo* is published every two months by the Istituto Geografico Militare in Florence, and is devoted mainly to researches in astronomy, geodesy, and cartography, but contains several articles on regional geography. The issues which have appeared maintain a high standard, and are well illustrated with plates and coloured maps. An article in No. 2 (March–April) gives a useful account of the Topographical Service of the Turkish Empire, and is illustrated with specimens and keys of the maps of various scales.

THE Meteorological Service of the Dominion of Canada is issuing a series of monthly weather charts. Each chart shows the mean temperature, the difference from the average mean temperature, and the total precipitation of the month throughout southern Canada. The highest and lowest temperatures at various stations are given in tabular form. Weather and agricultural reports for nearly 100 stations are added. There are also notes on the probability of gales on the Great Lakes in the month of publication.

THE problem of determining the forces which will act on a part of an actual aeroplane when in flight by observations on a model in a wind-tunnel is a very difficult one. An attempt at a solution of part of the problem has been made at the Bureau of Standards at Washington by Mr. H. L. Dryden, to whose work Scientific Paper No. 394 of the Bureau is devoted. By measuring the distribution of pressure on the surface of a cylinder with its axis at right angles to the wind-stream in a tunnel, Mr. Dryden shows that the decrease of pressure at the back of cylinders of small diameter is greater in proportion than the increase in front, and that, in consequence, the distribution of velocity is not similar about cylinders which are "dynamically similar"—that is, for which the product of the diameter, the speed, and the reciprocal of the dynamical viscosity of the wind has the same value. After showing that the size of the wind-tunnel, the effects of the guards, and of the gap between them and the cylinder cannot explain the difference, Mr. Dryden concludes that it is due to some unknown property of the air in the vortex motion behind the cylinder. He proposes to test this by taking photographs of this portion of the moving air.

THE second Report of the British Scientific Instrument Research Association, covering the work of the association from July 1, 1919, to June 30, 1920, is interesting reading. It is a striking example of the importance of applying scientific research and knowledge to the comparatively small things in life. The staff of the association, whilst preparing for a number of important researches, has been carrying out a series of investigations which, whilst small in themselves, are of importance to the scientific instrument industry. A polishing powder and some abrasives have been developed which have desirable properties, and which, it is hoped, will be manufactured commercially in this country. A research into tissue-papers has resulted in a specification which will enable opticians to obtain paper in which optical glass may be wrapped without tarnishing the glass. The association has produced a solder, fusing at a temperature of 195° C., capable of being used with aluminium, and this in itself is no small achievement. The report impresses the reader that every effort is being made to get into close touch and co-operation with other research organisations, such as the National Physical Laboratory, and at the same time the requirements of the users of scientific instruments are being continually studied. The future work of the association will be eagerly awaited by all makers and users of scientific instruments.

THREE papers on notched-bar impact tests were read at the Institution of Civil Engineers on November 30. The paper by Messrs. T. E. Stanton and R. G. C. Batson gives particulars of a series of tests made at the National Physical Laboratory with the view of investigating (*a*) the effect on the work of fracture and the consistency of the results obtained of a variation in the angle and sharpness of the notch in 10 mm. by 10 mm. specimens, and (*b*) the sensitivity of the various types of **V** notch in revealing faulty heat treatment. It was found that the shape of the bottom of the notch has an important effect, and the work of fracture has least value when the angle at the bottom of the notch is as nearly zero as can be obtained. Variations in the results of individual tests are not inherent in the method of test, but are due to a lack of homogeneity in the material. M. Charpy has found that by taking extraordinary care in heat treatment to ensure homogeneity it is possible to obtain a degree of uniformity in the results of notched-bar tests which is higher than any other mechanical test to which the material can be subjected. The National Physical Laboratory tests indicate that the 10 mm. by 10 mm. specimen developed by the Aeronautical Insoection Directorate, having a 45° notch with a radius of 0·25 mm. at the bottom, is as effective in the detection of faulty heat treatment as the Charpy specimen. Other tests on the dimensional effect with specimens of varying sizes indicate that the value of the impact test, as at present understood, lies not in discriminating between the impact resistances of different materials, but as a means of ensuring that the impact strength of any given material is at its highest. The paper by Messrs. R. H. Greaves and H. Moore also deals with notch radii, and that by Messrs. R. M. Jones and R. H. Greaves discusses tests made with the view of investigating the effect of overstrain.

THE use of wire-rope conveyors of the class having more than one rope has hitherto been restricted. This is owing to the fact that it has been the practice to attach the ends of the slats or their mechanical equivalents to separate ropes. Since it is not possible to splice separate endless ropes so that they shall all be of exactly the same length, strains are set up in the working which are fatal to success. This objection has been obviated in the Roe cable conveyor—described by Mr. G. F. Zimmer in *Engineering* for November 19—by fixing one end only of the slats or transverse carrier-bars to one endless rope, and the other end merely rests upon the other rope or ropes without being attached thereto. Thus two or more endless ropes of differing lengths may be used to provide a satisfactory support for the conveyor slats. In the conveyor illustrated in the article the total length is 1800 ft., and the difference in altitude between loading and unloading points is 15 ft. Ten brake-horse-power is required to drive the conveyor under full load at 150 ft. per minute. It is of interest to note that the invention owes its existence to the requirements of the War Office.

SOME particulars of the canal now under construction by the Hydro-Electric Power Commission of Ontario, Canada, are given in *Engineering* for December 3. The canal, which is said to be the largest for water-power purposes in North America, is about 8·5 miles long, and involves the removal of about 19,000,000 cubic yards of earth and rock. Water will be taken along the Welland River for about 4·5 miles from Chippawa, and thence through the canal proper to Queenston at the edge of the cliff marking the limit of the Niagara River Gorge. The power-house will be located at Queenston, where the net head available will be 305 ft. The actual difference in level between Lakes Ontario and Erie is 326 ft., and the present power plants at Niagara utilise heads of 150 ft. to 200 ft., which is the height of the falls alone. The additional fall in the new scheme is obtained by using a site beyond the rapids. The canal is designed to carry sufficient water to generate more than 400,000 h.p.

THE Journal of the British Science Guild for November contains an account of the annual meeting held in June last, when addresses were delivered by Lord Sydenham (the retiring president), Lord Montagu of Beaulieu (his successor), and others. Since then the Guild has lost by death its founder, Sir Norman Lockyer, and a past-president, Sir William Mather. In the account of the administrative activities of the Guild attention may be directed to the contribution by Dr. J. W. Evans, chairman of the Committee on the Utilisation of Science in Public Departments. Some interesting evidence of the results of undue centralisation in various Departments has been collected, and the need for a Royal Army Scientific Corps, with which should be associated a special research institution, is strongly emphasised. It is interesting to observe that the Admiralty now possesses a Scientific Research Department, and a specially contributed account of this new organisation appears in the Journal. Among recent papers on the Guild's objectives reference may be made to "The Human Factor in Industry," by Mr. Alexander Ramsay. An account is given by Prof. C. S. Myers of the work of the Institute of Industrial Psychology, which he represents as a *liaison* member on the Guild's executive committee. It is stated that the catalogue of British scientific and technical books in preparation by the Guild is now complete, and contains about 6000 titles. The scheme of forming provincial groups of the Guild appears to be making progress, the first local committee having been already set up in Aberdeen, with Prof. Alex. Findlay as secretary.

A COMPREHENSIVE and valuable catalogue (No. 408) of works relating to South Africa has just been circulated by Mr. F. Edwards, 83 High Street, Marylebone, W.1. It contains upwards of 700 titles. Many of the volumes are rare and difficult to obtain. Among the items offered for sale is the Godlonton correspondence—Sir Harry Smith: "A Collection of Fifty-one Autograph Letters, Signed, to the Hon. R. Godlonton," mostly marked "Private" or "Confidential," and wholly unpublished. The catalogue is one to be seen by librarians and others interested in the development of South Africa.

PROF. J. F. DOBSON, professor of Greek in the University of Bristol, and Dr. S. Brodetsky, lecturer in applied mathematics in the University of Leeds, have nearly completed their translation of the "De revolutionibus orbium celestium" of Nicholas Copernicus. The translation will be accompanied by a Life of Copernicus and some account of his influence and the history of the views connected with his name.

Our Astronomical Column.

TIDAL FRICTION AND THE LUNAR ACCELERATION.—Mr. G. I. Taylor contributed a paper to Phil. Trans., A, vol. ccxx., on tidal friction in the Irish Sea, from which it appeared that fifty Irish Seas would provide sufficient dissipation of energy to account for the secular acceleration of the moon. Dr. H. Jeffreys returns to the subject in Phil. Trans., A, vol. ccxxi., examining the various seas where such action is probable, and obtaining details of tides and currents from Admiralty publications. The seas that contribute most are largely enclosed, but an opening is required sufficient to admit the tide. The Mediterranean, Red, and Baltic Seas are thus excluded. Bering Sea is by far the largest contributor. It is concluded that two-thirds of the total action takes place there. The Yellow Sea, Malacca Strait, and the American North-West Passage come next. The famous tides of the Bay of Fundy contribute somewhat less than the Irish Sea.

The total rate of dissipation of energy is $2{\cdot}2\times10^{19}$ ergs per second. Taking the excess of the moon's secular acceleration above the portion due to diminution of eccentricity of the earth's orbit as 9″ per century per century (equivalent to 4½″ on the usual erroneous method of measuring by space gained instead of velocity gained), the equivalent dissipation is $1{\cdot}4\times10^{19}$ ergs per second. It is noted, however, that several of the data used were spring-tide values. Allowing for this, the agreement is quite as good as could be expected. It is the first time that a satisfactory estimate of the tidal friction has been made, and the author notes that it seems capable of satisfying all the quantitative demands made on it. He had previously expressed doubts on this point, but he had not then realised that the land-locked seas, not the open ocean, were the chief contributors.

Dr. Jeffreys also notes that the diurnal tides have a slight effect on the obliquity of the ecliptic, reducing it to $1/e$ of its original value in about 10^{11} years. The effect within historic times would be quite inappreciable.

THE SOLAR SPECTRUM FROM 6500 Å. TO 9000 Å.—Vol. vi., No. 3, of the Publications of the Allegheny Observatory contains an investigation of the red and infra-red region of the solar spectrum made by Mr. W. F. Meggers using plates stained with dicyanin and a large plane grating lent by the Johns Hopkins University; it was ruled by Prof. J. A. Anderson, and has 15,000 lines to the inch. The spectra of the opposite limbs of the sun were photographed in juxtaposition, the Doppler effect thus produced serving to distinguish solar and telluric lines. A large number of the latter are assigned (some tentatively) to water-vapour. The region 6500 to 7300 overlaps Rowland's table, the two tables being printed side by side. This region contains 473 solar lines and 596 telluric lines, while the region 7300 to 9000 contains 495 solar and 838 telluric lines. The infra-red spectra of many of the elements are still uninvestigated, but more than half of the solar lines in this region have been identified. In particular, the evidence for the presence of potassium in the sun is strengthened; besides the line at 4044 already known, lines are found at 7664 and 7699. The former partly overlaps a strong line in the A band of oxygen (telluric), but the Doppler effect permits it to be seen separately. There is a general absence of elements with high atomic weights; in explanation of this a sentence is quoted from Abbot's "Sun" (p. 253) stating that these elements would probably lie at too low a level for their lines to be seen at the limb. Seven elements (rhodium, ruthenium, palladium, gallium, europium, helium, and oxygen) are added to the thirty-six solar elements in Rowland's list. Oxygen is shown by the lines 7771, 7774, 7775, and 8446 (doublet); these lines have Doppler displacements.

Anthropology at the British Association.

ON the whole, the proceedings of Section H (Anthropology) at the Cardiff meeting may be counted as successful. The number of papers presented was fewer than usual—several contributors were obliged to withdraw at the last moment—nor did they all offer the opportunity for discussion which normally has been a prominent feature in this Section. There were, however, a number of communications of importance, and the attendances were good, notwithstanding the comparatively small number of members at the meeting.

Turning to the consideration of the chief communications in detail, attention may be directed to Prof. F. G. Parsons's paper entitled "The Modern Londoner and the Long Barrow Man," which was mainly a criticism of conclusions arrived at by the president of the Section (Prof. Pearson) and the late Dr. Macdonell. In a paper published some years ago the latter had given it as his view that the modern Londoner approximated to the type of the Long Barrow man. Prof. Parsons had examined skulls of Londoners of the eighteenth and nineteenth centuries, the Rolleston and Thurnham Long Barrow skulls, and numerous Anglo-Saxon and Mid-European skulls. As a result he maintained that when the modern Londoner departs from the Anglo-Saxon type it is in the direction of the Alpine folk rather than in that of the Long Barrow folk. An interesting fact which had emerged in the course of the investigation was that broad-headedness appeared to be on the increase in the modern population.

Prof. H. J. Fleure summarised the results of his investigation of the Welsh physical type. He finds that there are nine distinct physical types in Wales, and that, generally speaking, the Welsh people show more long-headedness and more dark pigment and are of shorter stature than the English, but that both are a complex mingling of different breeds.

A paper of great importance in the elucidation of problems of the early ethnology of the Mediterranean area was offered by Mr. L. H. Dudley Buxton. His communication "On the Physical Anthropology of Ancient Greece and Greek Lands" was based upon a study of the cephalic index, stature, upper facial index, and pigmentation of the modern population, and a comparison with the scanty early material available. The mean cephalic index varies from 79·20 in Crete to 87·51 among the Bektash of Lycia. The modern Greeks are slightly more brachycephalic than the ancient inhabitants of the same places. In Crete it would appear that there had been an immigration or extension of long heads in early times, which was later supplanted by a mixed round- and long-headed population. Tentatively he concluded that (1) the cranial index shows sufficient variety to suggest ethnic admixture; (2) this admixture has not been evenly distributed, and local and distinct sub-races have been formed; and (3) the admixture is early, possibly Neolithic in Leukas, and Bronze age (or earlier) in Cyprus or Crete. In regard to stature, large numbers are available from Crete and Cyprus only, but the same conditions appear to make for heterogeneity; the modern stature appears to be slightly greater than the ancient; but, owing to the small numbers represented, caution is needed in ascribing high or low stature to any race in the area. At both boundaries of the Greek world there are two racial types of comparative homogeneity; the intermediate people, who present local divergences, are very variable. The Greeks are a combination, probably early, of Alpine and Mediterranean stocks.

Miss Tildesley, in a communication on the Burmese skull, established by means of a co-efficient of racial likeness that the Burmese skull is closely akin to the Malayan and less closely to the Chinese, while being widely removed from the Caucasian type.

In Ethnography Dr. W. H. R. Rivers, in a communication on the statues of Easter Island, suggested that these may represent the hypertrophy of one element in an association similar to that found in San Christoval, where stone images represent the dead chief buried in the pyramidal structure with which the images are associated. The presence of this hypertrophy in Easter, Pitcairn, and Lavaivai Islands suggested that immigrant workers in stone thus obtained a means for the expression of religious and artistic impulses to which the fuller life of the larger islands of Polynesia and Melanesia gave other outlets. The crowns of red vesicular tufa, he held, represented hats rather than hair, either natural or in the form of wigs, as has been suggested, and might be compared with the hats which are prominent symbols of the dead in Melanesian societies which practise the ghost cult.

Capt. L. W. G. Malcolm dealt with the anthropogeography of the Cameroons, and in particular with that of the area in which the Bantu-speaking peoples came into contact with the Sudanese; and Prof. E. H. L. Schwarz described certain elements in the culture of the Ovambos, to which he endeavoured, upon somewhat slender evidence, to find analogues in the customs of early historical races which were in contact with Africa.

A very successful afternoon session was devoted to primitive music, with special reference to Wales. Dr. H. Walford Davies, in a paper on "Euphony and Folk Music," pointed out that the pentatonic scale, the simplest known form, which recurs all over the world, epitomises the simpler tone-relationships, and is the basis of the Dorian mode, in which so much of the British folk-music is written. Dr. J. Lloyd Williams, in describing Welsh national music, pointed out that while a considerable body of the music shows the influence of the harp, in vocal music, of which an unexpected wealth had recently been discovered, a considerable proportion was in the Dorian and other modes. Of traditional lyrics the best were the very numerous penillion; these, and the singing of penillion according to North Wales style, constitute unique features in Welsh song.

Archæological papers furnished the most interesting section of the programme. Prof. W. M. Flinders Petrie described recent discoveries of the British School in Egypt, which included a series of tombs of every variety of type of the First to Third Dynasties; the tomb of the royal architect of King Senusert II., whose gold uræus was found in his pyramid; and a large alabaster jar with a magic inscription to provide all offerings required. Three inscriptions of the Twelfth Dynasty, in alphabetic signs, show that the prehistoric system of personal marks had by that time grown into regular writing, independent of any Semitic system.

Mr. P. E. Newberry, in his communication "Early Egypt and Syria," suggested that the parent culture of the early civilisations of the Nile and the Euphrates should be sought in Syria. The ox, the sheep, and the goat were introduced into Egypt through Syria, and the crook and the flail, the royal insignia of dynastic Egypt, were both of Western Asiatic origin, the former being the crook of the goatherd, and the latter, it was suggested, an instrument used by goatherds for gathering ladanum from the cistus bush, which was not found in Egypt. The cults of the *neter*-pole and the *ded*-column, both of which were originally coniferous tree-trunks, must have been of Syrian origin. The traditional home of Isis and Osiris was between Byblos and Damascus, and there the vine and wheat and barley grew wild. The Egyptian house was obviously derived from a wood-built dwelling, and both Egypt and Babylon are known to have drawn their timber from the Lebanon area.

Mr. R. Campbell Thompson, in a paper on "Prehistoric Dwellers in Mesopotamia," maintained that a proto-Hamitic section of the Mediterranean race which migrated at an early time into Arabia was the forerunner of the Semitic peoples.

Mr. S. Casson described the recent excavations at Mycenæ of the British School of Archæology at Athens, which had been carried out in the light of a reconsideration of Schliemann's discoveries. The Grave Circle, as well as a stratified platform of earth outside the Acropolis, the site of a part of Mycenæ in the period 2000–1500 B.C., showed traces of a Bronze-age civilisation, and even of Neolithic remains. It seemed certain that there was a continuous mainland civilisation stretching back at least to the beginning of the second millennium B.C. In the replanning of Mycenæ by the later kings, such as Atreus, by whom the Lion Gate and the Acropolis wall were built, the burial-ground of their forerunners was enclosed by the Grave Circle. This was used as an ossuary, outlying graves being cleared and their contents placed within the circle.

Mr. Joseph S. S. Whitaker's paper on "Recent Anthropological Research at Motya" described the remains brought to light on the Island of San Pantaleo, on the north-west coast of Sicily, which is undoubtedly the site of the ancient Phœnician colony of Motya, and, owing to its complete and sudden overthrow in 397 B.C., probably shows more remains of an old Phœnician town than any other known site. Excavation has revealed that the island was originally fortified by a wall all round, and the north and south gateways have been discovered. The north gate consists of an outer gateway formed of two apertures, recalling the Athenian Dipylon Gate, and a second, twenty-two metres behind it, of six apertures in pairs. In a cemetery—the first to be discovered—the prevailing method of disposal of the dead was incineration, although in the later cemetery on the adjacent mainland inhumation was chiefly practised. One burial-place belonging to the last period contained only the remains of animals, mostly ruminants, in single urns. An interesting mosaic pavement showed a combination of Phœnician picture-panels and Greek decorative borders.

Signor G. Bagnani dealt with the results of recent archæological investigations in Rome, some of which had not hitherto been described, including the Roman basilica at Porta Maggiore, the tomb on the Via Ostiense, and the tombs found under the Church of San Sebastiano.

Dr. T. Ashby, in a joint communication by himself and Mr. Robert Gardner, described further observations of the Roman roads of Central and Southern Italy, in particular of the Via Valeria, through the Abruzzi, the Via Latina, and the Via Cassia, through Etruria. An attempt to trace the Via Herculia between Venusia and Potentia was unsuccessful.

Mr. G. H. Garfitt's paper on a recent discovery of rock sculptures near a stone circle in Derbyshire described cup- and ring-markings and two sculptured stones found near the circle on Eyam Moor. On the latter are represented a deer-horn pick and a plough. A comparison with dolmenic sculptures in Brittany suggests an association with the Ægean goddess of fertility, whose cult may thus have extended to Derbyshire. Mr. MacRitchie brought forward evidence to show that early references to Greenland must be taken to denote some European country, probably the area between West Sweden and the Urals, and indicated the bearing of this conclusion on European ethnology. Mr. Kidner described certain round barrows in the New Forest which do not conform to the three standard types; and Mr. Willoughby Gardner described his recent excavations in the Dinorben hill-fort near Abergele, which had fully confirmed previous conclusions as to the character and construction of the fort.

An afternoon session was devoted to an expedition to the site of the Roman city of Venta Silurum at Caerwent under the guidance of Dr. T. Ashby, who was in charge of the excavations carried out with the assistance of the Association on that site some years ago. As a preliminary to the excursion Dr. Ashby also gave the Section an account of the results of these excavations.

E. N. F.

Smoke Abatement and Housing Schemes.

A SUPPLEMENT to the *Lancet* of November 20 contains the annual report of the Advisory Council on Atmospheric Pollution for the year April, 1919–April, 1920. The number of stations sending in full returns is nineteen, of which fifteen are divided between London and Glasgow, the other four being Malvern, Rothamsted, Southport, and St. Helens.

It will be seen that the number for the whole country is very limited, and some of the dirtiest industrial centres, where a comparison of the conditions of the atmosphere from year to year might be of some advantage to the local authorities, are entirely unrepresented. This arises, no doubt, partly from the complete indifference shown in many localities to the smoke nuisance, and partly from the troublesome and tedious analytical method of estimating atmospheric impurities. Something in the way of an automatic recorder or an apparatus not requiring much supervision would probably induce many places which at present send in no returns to adopt the system.

It should be pointed out that the Council fully recognises this desideratum, and the report shows that a considerable amount of research has already been carried out with no little success in simplifying the apparatus for recording both solid and acid impurities. That the prevalence of the latter impurity is the main factor in the disintegration of the stonework of many of our ancient monuments has been proved beyond question, and some check on the quantity is a matter of great importance.

It is to be presumed that it is no part of the Council's business to advance the cause of smoke abatement apart from the registration of statistics, yet it seems to us that a systematic propaganda against smoke pollution might form a useful adjunct to its other activities.

Under the new housing schemes emanating from the Ministry of Health an opportunity is offered for the erection of houses in such a way as to diminish considerably the output of smoke, and, in fact, under the auspices of the Ministry a Committee was summoned to inquire into and report on the subject. The report of this Committee was issued some months ago, but it appears from a statement made in the House of Lords by Lord Newton, chairman of the Committee, that neither the Department for which it was prepared, nor the local authorities for the benefit of which it was issued, appear to have paid any attention to its practical application.

We would suggest, therefore, that the various schemes referred to in the report, and generally approved by competent persons, should be taken up by the Advisory Council on Atmospheric Pollution, who should bring it before the notice of the public in the form of active propaganda. It seems useless to make yearly records of air pollution when no serious steps are being taken, publicly or privately, to diminish the evil.

J. B. C.

Work of the Analytical Laboratory, Cairo.

SEVERAL features of more than passing interest are shown in the undermentioned report.[1] Covering as it does the period of the war, it chronicles work—such as the making of special incendiary bombs and chemical igniters for flares—which is rather unusual for the analytical laboratory, but is an indication of versatility in time of need. Passing, however, to more normal activities, with a bare mention of the excellent routine work done, it is interesting to note that research has taken a definite place in the programme of the department; the authorities are evidently alive to the importance of encouraging the application of chemistry to arts and manufactures. Thus an investigation of Egyptian crude petroleum has been made, the results of which have proved that good yields of Diesel fuel-oil can be obtained from this source, besides the customary petroleum spirit and kerosene, and a pitch which will be invaluable for road-making. A Government refinery to deal with this crude petroleum is to be erected at Suez.

An inquiry into the possibility of cement manufacture in the Sudan was also undertaken. As a result a cement factory is now being constructed at Makwar, where 50,000 tons of cement per annum will be made; the fuel difficulty has been overcome by using a mixture of locally made charcoal and imported coke.

Among the chemico-legal cases dealt with was an interesting one in which a claim was made against the Government for land valued at about 16,000,000*l*. Unfortunately for the claimant, however, it was found that out of the 168 documents on which the claim was based no fewer than 163 were forged.

It is noted that an entirely new method of assaying gold has been devised, whereby the Assay Office was enabled to cope with a very considerable increase of work resulting from the new assay law, which provides for the compulsory hall-marking of gold and silver. The report indicates useful work and steady progress.

The Problem of Soaring Flight.[2]

THE source of energy used by birds in soaring flight is not yet clearly known. Attempts have been made to achieve this form of flight artificially, and, according to Gustav Lilienthal, a flight of 500 metres up wind, in which a height of 40 metres was attained, has been made by a man-carrying glider not provided with a motor, but having wings constructed on the pattern of those of a soaring bird.

The extraordinary regularity with which cranes, when flying in a group, keep their distances from one another affords a proof that such soaring flight is either due to undiscovered wing-movements or to some condition of the air which is widely and uniformly distributed. The observation that certain dragon-flies, and also flying-fishes, employ soaring flight has led to discoveries that throw a new light on the subject. Dragon-flies can adjust their abdomens and hind-legs, and flying-fishes their pelvic fins, in such a way that these organs act as a brake to check speed when flying. The brake is used in certain conditions in continued flight to keep their speed at a required minimum. This use of an air-brake yields a proof that these instances of soaring flight are not due to undiscovered wing-movements. Dragon-flies habitually avoid ascending currents when in soaring flight so long as the sun is shining. If isolated clouds are crossing the sky these insects collect in the neighbourhood of a convenient ascending current, entering it whenever the sun is obscured, and gliding beyond its range so soon as the sun comes out. That soaring flight is not due to the lifting effect of lateral gusts is proved by the fact that the flying-fish when at highest speed carries its wings inclined so that the wing-tips are on a lower level than the body. In this case, if lateral gusts were operative, their only effect would be to drive the fish under water

Certain facts suggest that turbulent motion is, in some unknown way, the source of the energy of soaring flight. But light objects, such as feathers or aerial seeds, may be seen floating in the air in the neighbourhood of soaring birds, and exhibiting only slow and equable movement. What form of turbulent motion can be imagined that enables a bird weighing 10 lb. or more to glide without effort to a height of 2000 metres or to travel horizontally for indefinite distances at a speed of 50 miles an hour, and yet is unable to disturb the course of a piece of thistledown? Thus the facts of the case appear to offer insuperable difficulties to all theories that have hitherto been put forward as an explanation of soaring flight.

University and Educational Intelligence.

CAMBRIDGE.—The proposal to admit women to membership of the University on equal terms with men was rejected on December 8 by 904 votes to 712. The next step, presumably, will be a vote on Report B, the alternative proposal offered by the recent syndicate. This is, in effect, a suggestion on the part of the University that it would welcome the foundation of a separate University for women at Cambridge, and would extend to it the same facilities for educational purposes as are at present offered to the members of Girton and Newnham Colleges. This proposal does not in any way meet the greater number of the difficulties that were raised in connection with the rejected scheme, in particular the question of numbers and accommodation. It has already been rejected by the women's colleges, which have declared that they have no intention of taking action in the matter of forming a separate University even if Report B is passed. Already three of the six signatories of Report B have, in a sense, abandoned it for some scheme which shall more nearly meet the women's needs, a scheme the details of which have yet to be worked out. It does not look as though the adoption or rejection of Report B by the University will bring the problem nearer to an agreed settlement. In the interests of the University as a whole, and of the women's colleges in particular, an early settlement must be reached, and it looks as though the next move must lie with "the party of thirteen," who have in view a scheme which will give the women the full privileges of membership of the University without any control over the men's education. If they take early and effective action they may be able to justify

[1] "Report on the Work of the Government Analytical Laboratory and Assay Office, 1913–1919." (Ministry of Finance, Egypt.)

[2] Abstract of a paper by Dr. E. H. Hankin and F. Handley Page read before the Cambridge Philosophical Society on November 22.

the vote of last Wednesday; otherwise, this vote must bring a reaction which may, in due course, sweep much farther than the original proposals.

Mr. J. Gray, fellow of King's College, has been elected Balfour student.

LONDON.—Mr. F. R. Fraser has been appointed for a period of four years as from October 20 last to the University chair of medicine tenable at St. Bartholomew's Hospital Medical School. In 1912 Mr. Fraser was appointed assistant in medicine at the Rockefeller Institute for Medical Research in New York, and two years later instructor in clinical medicine at Columbia University. During the war he served with the R.A.M.C., and on demobilisation was appointed assistant director of the Medical Clinic and assistant physician at St. Bartholomew's Hospital. He is the author of publications on electrocardiographic changes and acute poliomyelitis.

OXFORD.—Mr. R. T. Gunther, fellow and tutor of Magdalen College, has been elected by that college to a research fellowship in order to continue his researches on land levels in the Mediterranean. A science tutorship at Magdalen will thus become vacant, and it will certainly be acceptable to biologists in Oxford if another biologist be elected to succeed Mr. Gunther. Magdalen College has long been favourably distinguished for the support it has given to scientific study and research, especially in subjects connected with the sciences of life.

PROF. J. C. IRVINE, professor of chemistry in the University of St. Andrews, has been approved by the King, on the recommendation of the Secretary for Scotland, as Principal of the University in succession to the late Sir John Herkless.

APPLICATIONS are invited by the council of Bedford College for Women, Regent's Park, for a scholarship in sociology tenable at the college for two years, and of the yearly value of 80*l*. Candidates must be women holding a university degree or its equivalent. The latest date for receiving applications is January 15.

THE Association of Science Teachers will hold a general meeting on Tuesday, January 4, at University College, London, when the presidential address will be delivered by Miss M. B. Thomas, Girton College, and a lecture on vitamines will be given by Dr. J. C. Drummond, reader in physiological chemistry, University College. The hon. secretary of the association is Miss E. M. Ridley, 10 Gresley Road, London, N.19.

THE Salters' Institute of Industrial Chemistry has awarded five fellowships for post-graduate study in the laboratories indicated:—Mr. A. H. Adcock (Liverpool University), Mr. J. A. Gentle (Oxford), Mr. S. J. Saint (Reading), Mr. C. B. Taylor (Imperial College of Science and Technology), and Mr. Donald Turner (Sheffield). Scholarships have been awarded to Messrs. M. D. Forbes and G. M. Lowe (Imperial College of Science and Technology), A. W. Pritchard and F. W. Turner (East London College). Forty-five grants in aid have been awarded to chemical assistants occupied in factories in or near London to facilitate their further studies

ANNOUNCEMENT has been made that four fellowships of 1000 dollars each have been established through a co-operative agreement between Yale University and the Bishop Museum of Honolulu, Hawaii. The fellowships are available for graduates of any institution, but are primarily designed for students who have already attained the degree of doctor of philosophy. Preference will be given to applicants who desire to carry on research in anthropology, botany, zoology, geography, or geology in Hawaii or other parts of Polynesia. Detailed information may be obtained from the Dean of the Graduate School, Yale University.

THE annual meeting of the Mathematical Association will be held at the London Day Training College on Tuesday, January 4. The programme includes the following papers and discussions:—Relativity, Prof. A. S. Eddington; Aeroplane Mathematics, Dr. S. Brodetsky; The Teaching of Mathematics to Boys whose Chief Interests are Non-Mathematical, the Rev. S. H. Clarke; Some Unsolved Questions and Topics for Research, Prof. E. T. Whittaker; Results of Visits Paid to Lycées of Paris and other Centres, and the Study of Education there, particularly from the point of view of Mathematics, Miss E. M. Read. January 17, 1921, will be the fiftieth anniversary of the first recorded meeting of the association.

PROF. DONNAN gave an interesting address on "The Finance of Research at Universities" at a meeting convened by the London branch of the National Union of Scientific Workers at University College on December 9. He said that scientific research must be financed mainly out of Treasury funds, and as the Treasury is influenced greatly by public opinion, it behoves scientific workers to create the right atmosphere. The Government, no less than the general public, is apt to overlook the fact that there are three equally important factors in the creation of wealth. Two of these, new knowledge and trained men to apply it, are the right products of the universities; increased production is not merely a question of the hours of labour of the manual worker. The nation has already reached a time of financial stress which will probably continue for another five years. Hitherto the Government has treated educational institutions as charities, to be given doles in times of prosperity, to be ignored at the call for economy. Unhappily, this attitude is unchanged, and the prospect of universities receiving the necessary financial assistance from the Treasury for research workers is a poor one unless the Department of Scientific and Industrial Research realises in time that this is the more productive field for cultivation, and unless those best equipped and best entitled to benefit by grants, viz. the junior teaching staffs, are aided to undertake research work instead of being forced by inadequate salaries to make ends meet in other ways. Prof. Donnan concluded by paying a tribute to the work of the Department of Scientific and Industrial Research in fostering industrial research associations, but expressed the doubt as to whether it would not have been the more profitable investment to have started with the university research workers.

ANYONE who understands the best possibilities of the kinematograph, or has seen some of the instructive films now available, must realise that the instrument may be made a very valuable educational aid. In scientific instruction, for example, the slowing down of ultra-rapid pictures enables movements to be analysed most clearly; or, on the other hand, a film may show in a few minutes the life-history of a plant or animal, and thus synthesise changes which may extend normally over several months. Whatever can be said in favour of the use of pictures in text-books can be applied with far greater force to the motion picture, for movement impresses itself upon the mind much more deeply than still-life. This is particularly true of geographical subjects, the aim of which is to give pupils clear ideas of the characteristics of countries and peoples in various parts of the world. It has hitherto been difficult to obtain instructive films of this kind for exhibition except by applying to a number of different firms. The Macmillan Educational Film Co., Ltd., 32 Charing Cross, S.W.1, has now, however, made a collection of educational and scientific films which they are able to offer for hire. We have before us a list of such films relating to geographical, industrial, Nature-study, and other subjects, and a copy can be obtained by anyone upon application to the company. There are also lists of suggested programmes—one of a varied kind, and another in which geographical subjects are appropriately grouped together. It may be hoped that local education authorities will avail themselves of such assistance as is afforded by these lists to give a new character to kinematograph displays in local picture-houses. In the United States thousands of schools make use of the moving picture for educational purposes, and there is a great opportunity for its wise employment here when existing prejudices have been overcome.

Societies and Academies.

CAMBRIDGE.

Philosophical Society, November 22.—Prof. Seward, president, in the chair.—F. A. **Potts**: A note on vital staining. In studies which have been made on the penetration of neutral red into the living body of the soil nematode Diplogaster it is found that most of the stain makes its way through the mid-gut and none through the skin. In the mid-gut a zone of granules arranged peripherally round the lumen of the gut takes up the stain particularly.—W. F. **Lanchester** and A. G. **Thacker**: Preliminary note on the superior vena cava of the cat. Thirty cats were dissected to observe the point of entrance of the internal jugular, which in every case except one fell into the external jugular. Observations were also made on the length of the superior vena cava in twenty-one adult cats, and the length appeared to be varying round more than one mean.—Miss M. D. **Haviland**: Preliminary note on a Cynipid hyperparasite of Aphides. Charips (Cynipidæ) is a hyperparasite of Aphides through Aphidius (Braconidæ). The female pierces the Aphidius larva while the latter is lying inside the living Aphid, and deposits an egg within its body. The first-stage larva of the Cynipid is hypermetamorphic, with a thick chitinous skin and tail, but during development, which takes place within the Aphidius, the larva gradually assumes the form usual among parasitic Hymenoptera. Shortly before metamorphosis the hyperparasite leaves its host, the remains of which it devours, and its tracheal system becomes functional. It afterwards pupates within the cocoon previously woven by the Braconid.—Dr. E. H. **Hankin** and F. Handley **Page**: The problem of soaring flight (see p. 518).—Sir George **Greenhill** and Dr. G. T. **Bennett**: The rotation of a non-spinning gyrostat.—E. V. **Appleton**: A method of testing triode vacuum tubes. A dynamic method of measuring the slope of the principal voltage-current characteristic of a three-electrode thermionic tube is described.—W. B. **Frankland**: The astronomical bearing of the Einstein theory.—Dr. W. **Burnside**: The representation of the simple group of order 660 as a group of linear substitutions on five symbols. Except in the cases of two and of three variables, the explicit forms of groups of linear substitutions have been given only in a few cases. Thus it is hoped that the explicit forms in the case referred to may be of interest. The existence of a cubic three-spread, in space of four dimensions, admitting a group of 660 collineations into itself may be compared with the more familiar case of Segre's cubic three-spread which admits a group of 720 such collineations.

MANCHESTER.

Literary and Philosophical Society, November 2.—Sir Henry A. Miers, president, in the chair.—Dr. W. J. **Walker**: The polytropic curve and its relation to thermodynamic efficiency (with a note on the theory of the uniflow steam-engine). An inquiry made into the reason for the diminution of internal-combustion engine efficiencies when the value of n in the equation, pv^n = constant, for the compression line is reduced by water injection or other means.—W. H. **Pearson**: Notes on a collection of Hepatics from the Cameroons, West Coast of Africa. The collection, made by Mr. W. G. Travis from logs of ebony in the Liverpool docks, contained the following species: *Aneura Travisiana*, n.sp., Pears.; *Lophocolea Newtoni*, St.; *Mastigolejeunea* . . . ?; *Homalolejeunea excavata* (Mitt.), Sp.; *Ceratolejeunea Saxbyi*, n.sp., Pears.; and *Cheilolejeunea Principensis*, St. The type-specimens are in the Manchester Museum.

SHEFFIELD.

Faraday Society and Institute of Metals (Sheffield Section), November 19.—Afternoon session, Prof. C. H. Desch in the chair.—Dr. L. **Aitchison**: Electroplating for the prevention of corrosion. The paper dealt more especially with the protection of iron and steel and their alloys. The conditions for proper protective coatings were defined and the value of the various protective coatings was discussed with relation thereto.—W. A. **Thain**: Some applications of electrodeposition in aeronautical engineering. Three cases of the electro-deposition of copper were considered, viz.: (1) As a protection against carburisation in case-hardening practice; (2) as a means of increasing heat conductivity; and (3) as a means of building up a definite constructional detail.—B. **Carr**: The electrodeposition of cobalt. From a bath containing 4½ lb. of cobalt sulphate crystals, 5½ oz. of boric acid, and 2½ oz. of sodium chloride per gallon, and used at 34° C., excellent hard, adherent deposits of cobalt were obtained, provided that these were not too thick, with 150 and 72 amperes per sq. ft. for periods of immersion not exceeding 2 and 4 minutes respectively. The deposit is exceedingly resistant to atmospheric corrosion, and superior to nickel in the rapidity of deposition and hardness.—W. E. **Hughes**: The use of colloids in the electrodeposition of metals.—S. **Field**: The commercial electrolysis of zinc sulphate solutions. Commercial electrolysis aims at the maximum extraction of zinc with a minimum of energy. The greater the extraction the smaller the volume of liquor which circulates through the extraction plant, and the smaller the proportion of zinc which demands repeated purification. A limit to this extraction is set by the cost of increased energy necessary to take out zinc from dilute liquors. Current efficiency is dependent upon a number of factors, including current density, amount of zinc present, temperature, and the presence of impurities.

Evening session, Mr. E. A. Smith in the chair.—W. R. **Barclay**: Electro-silver plating and its technical development. This paper dealt with the history of technical investigation and research into the electro-deposition of silver so far as the more practical aspect of electro-plating is concerned. Emphasis was laid on the necessity for careful co-ordination of the factors of metal and free cyanide content to that of current density. It was shown that though considerable latitude is allowable in practice, the best results and highest efficiency lie within fairly well defined limits. It was pointed out that silver solutions in existence more than sixty years still continued to yield excellent results, and that, generally, old solutions yielded better deposits at higher current densities than those newly made up from pure materials. This was due in a great measure to the presence of substances other than the simple double cyanide of silver and potassium, especially potassium carbonate.—G. B. **Brook** and L. W. **Holmes**: The chemical composition of old silver-plating solutions, with observations on their working properties. The paper dealt with a large number of solutions varying in age from one to fifty years, furnishing historical, chemical, and physical data with regard to each, and correlating the composition with the working properties in actual works practice.—F. **Mason**: A new maximum current density in commercial silver-plating. With a free cyanide content in excess of that usually advised, and with potassium carbonate in considerable quantities, not only can the current density be increased enormously, but the deposit is of an exceptionally fine texture and takes a high finish.—G. B. **Brook**: The crystalline structure of electro-deposited silver.—S. **Field**: The deposition of gold-silver alloys. A series of experiments has been carried out in order to trace the influence of varying conditions on the composition of the gold-silver alloys deposited in the well-known "green gold."

DUBLIN.

Royal Dublin Society, November 23.—Dr. F. E. Hackett in the chair.—Prof. H. H. **Dixon** and Nigel G. **Ball**: A determination, by means of a differential calorimeter, of the heat produced during the inversion of sucrose. The heat of inversion of sucrose in presence of invertase was determined by means of a differential calorimeter in which the temperature was measured with a sensitive thermocouple. Two vacuum flasks were employed, in one of which the reaction took place, while the other was used as a control, one junction of the thermocouple being in each flask. The enzyme solution was contained in a capsule of paraffined paper immersed in the sugar solution to secure that both were at the same temperature. In the control flask a similar arrangement was used, but the enzyme solution had been previously heated to 100° C. These capsules could be ruptured without opening the flasks. The temperature effects of dilution of the sucrose were eliminated by these arrangements. Stirring was effected by shaking the flasks. A value for the heat produced during the inversion of sucrose by invertase was obtained which agrees closely with that previously given by Brown and Pickering, the mean of the results being 3·83 calories per gram-molecule.

PARIS.

Academy of Sciences, November 22.—M. Henri Deslandres in the chair.—A. T. **Schloesing**: The separation of two salts having a common ion. In the preparation of ammonium nitrate from sodium nitrate and ammonium bicarbonate an aqueous solution of sodium nitrate and ammonium nitrate is obtained, from which the latter salt has to be extracted. Solubility curves of mixtures of these two salts have been worked out and are given in the paper and the mode of applying these to the problem is indicated.—E. **Imbeaux**: New systems of electric towing on canals. The haulage difficulties on canals with numerous locks, such as those of the Marne, Rhine, and the Sarre coalfields, are summarised, and a description is given of the systems at present in use.—E. **Ariès**: The heat of evaporation of a liquid at low temperatures. Reply to a note of M. G. Bruhat.—T. **Varopoulos**: Algebroïd functions and increasing functions.—J. **de Lassus**: The essential properties of pneumatic transmission in a closed cycle.—J. **Andrade**: The last perturbations of isochronism.—W. **Margoulis**: A new method of testing aerodynamic models in gas currents. In existing apparatus serious errors may arise, as it is impossible to observe the conditions required by the law of similitude. The author suggests the replacement of air by carbon dioxide at high pressures and temperatures, and gives formulæ showing the resulting reduction in the horse-power of the motor necessary for moving the gas.—Lord **Rayleigh**: The light diffused by argon. Remarks on a recent paper by M. J. Cabannes.—C. **Matignon** and M. **Fréjacques**: The transformation of ammonia into urea. The problem of the economical transformation of ammonia into urea is of undoubted technical interest, since it contains 47 per cent. of nitrogen as against 35 per cent. of nitrogen in ammonium nitrate, and it behaves as an excellent manure. An account is given of studies on the conversion of ammonium carbamate into urea.—A. **Muguet** and J. **Seroin**: The age of the autunites of Portugal. These minerals are of recent formation, and were formed between 1250 and 1900 years ago. The figures are based on the determination of the ratio of radium to uranium in the minerals.—G. **Denizot**: The stratigraphical position of the Montabuzard limestone.—A. **Rolland**: The existence of formations of ground called *rideaux* in Cantal.—R. **Souèges**: The embryogeny of the Urticaceæ. The development of the embryo in *Urtica pilulifera*.—A. **Chevalier**: The variations of the buds of cultivated trees and shrubs as a cause of decadence of old varieties.—J. **Barlot**: New colour reactions utilisable for the diagnosis of mycological species. The colour reaction with potash solution serves to distinguish between the poisonous *Mycena pura* and the variety *amethystina* of *Laccaria laccata* (edible). The same solution gives different colour reactions with *Gomphidius glutinosus* and *G. viscidus*.—P. **Dangeard**: Metachromatine and the tannic compounds of the vacuoles.—W. **Mestrezat** and Mlle. Marthe **Paul-Janet**: The comparative evaluation of the total nitrogen in urine by the methods of Dumas and Kjeldahl. The Kjeldahl method applied to urine gave only from 98·5 per cent. to 90·3 per cent. of the nitrogen found by the Dumas method.—A. **Damiens**: The toxicological detection of poisons containing bromine. An application of the methods described in previous communications for the detection and estimation of traces of bromine in animal tissues.—G. **Bohn** and Mme. A. **Drzewina**: Variations of sensibility to soft water of the Convoluta, according to the physiological states and the number of animals under experiment.—L. **Joubin** and E. **Le Danois**: Biological researches on the thermometry of the Atlantic off Ushant during the summer of 1920. The data obtained are represented on two diagrams, showing the distribution of temperatures in a section W.-N.W. through Ushant.—C. **Lebailly**: The conservation or disappearance of the virulence of apthous milk in the course of the manipulations following treatment. If the contaminated milk is allowed to stand for cream long enough for an incipient lactic fermentation to take place the virus is attenuated or destroyed, and young animals fed on such milk during an epidemic have either remained healthy or have had only a mild attack. When the milk is collected in large creameries and the cream quickly separated mechanically, the skim milk rapidly spreads the fever.

ROME.

Reale Accademia dei Lincei.—(Communications received during the vacation.)—G. **Fano**: Surfaces of the 4th order with infinite discontinuous groups of birational transformations, ii.—C. **Crema**: Deposits of bauxite in the Apennines, Istria, and Dalmatia (with illustration of section).—C. **Artom**: Biology and systematics of the genus Artemia, ii.—M. **Genna**: Nutrition of *Anopheles claviger*. The male feeds only on sweet juices, but the female also requires to suck blood before it can lay its eggs. The processes of digestion of the two kinds of food are not only different, but they take place in different organs in the female.

(Vol. xxix. (2), i., ii.)—S. **Pincherle**: Iterated function of a rational integral one, ii.—G. **Fubini**: Projective differential geometry.—E. **Artini**: Cassiterite and titanite of Baveno. The former mineral was represented by a small crystal 5 mm. long and 4 mm. broad, being a multiple twin crystal found by G. Codara in the granite mines, and a few fragments discovered on a later visit. Of titanite the author possesses three small purplish crystals. Both minerals are new to the granite of Baveno.—C. **de Stefani**: Siliceous fossil sponges of western Liguria. These were found mainly in crystalline schists, but also in Triassic limestone, between Genoa and Savona. The majority are Hexactinellidæ dichyoninæ, and the structure was well preserved both in microscopic sections and in specimens treated with acid.—G. **Marletta**: Abelian varieties.—P. **Nalli**: A functional equation.—M. **Pascal**: Resultant pressure on an aeroplane wing, ii. A continuation of the previous hydrodynamical problem of two-dimensional stream-line motion in an incompressible fluid. The present paper proceeds to calculate the lift.—L. P. **Eisenhart** (of Princeton University): Congruences of spheres of Ribaucour which admit of a finite deformation.—R. **Serini**: Theory of the circular plate electric condenser.—E. **Adinolfi**: Centres of absorption of coloured solutions. The author describes a method in which the absorption spectra are observed in solutions of variable density, using a cylindrical receiver which acts as a lens.—R. **Ciusa** and L. **Vecchiotti**: Nitro-derivatives and nitrohydrazones, ii.—M. **de Angelis**: Crystalline form of nitrodibromoacetanilide.—M. **Gortani**: The Permo-Carboniferous and Permian formations in the Caracorum chain.—V. **Novarese**: The Cambrian of Iglesias.—G. de A. **d'Ossat**: Chalk and American vines. The effect of chalk in giving rise to chlorosis in vines already forms the subject of abundant literature. The present experiments appear to negative the empirical results previously obtained, while they suggest that methods adequate for the requirements of practical viticulture may be comparatively easy to carry out in working.—V. **Bambacioni**: Fibrillar structures of Nemec. The protoplasmic cords present in the cells of the radical apices in most plants do not present the complex structure described by Nemec, but in *Aspidium aculeatum* structures are observed comparable with his fibrillæ.—C. **Artom**: Biology and systematics of the genus Artemia, iii.—C. **Jucci**: Differentiation of caste in the society of termites, i. The neotenics.—E. **Artini**: Presence of chrysoberyl in the dolomite of Campolongo (Canton Ticino).—G. **Marletta**: Abelian varieties, ii.—P. **Nalli**: A functional equation.—E. **Adinolfi**: Influence of dissociation on permanganate. As in the previous paper mentioned above, researches on absorption centres can advantageously be made with solutions of concentration rendered variable by diffusion. Permanganates of potash and of lime have the same absorption spectra, and dissociation has no influence on the absorption spectrum of the potash compound.—V. **Cuttica**: Thermic analysis of the system of nitrate of thallio-nitrite of thallium. In view of the thermic behaviour of fused mixtures of $TlNO_3$ and $TlNO_2$, the author excludes the formation of complexes. The two salts form a continuous series of mixed crystals and the transformation to the solid state is referable to Roozeboom's second type in the classification of binary systems with polymorphic transformations.—G. **Cusmano**: Catalytic reduction of *o*-nitroazoxybenzol.—C. **Jucci**: Differentiation of caste in the society of termites, ii. The neotenics.—M. **Boldrini**: Sexual differences of weight in the human body and organs. A table showing the relations between the medians, the probabilities of transvariation, the relations between the arithmetical means, and the intensities of transvariation for numerous series of weights of male and female individuals and organs. The table furnishes a summary of the observations of Frascani, Demoor, Benedict, Bischoff, Bean, Boldrini, and others, the subjects observed including new-born infants from Pisa, Brussels scholars, white and black Americans, Germans (both living and dead), Romans, and a few French and others.

CAPE TOWN.

Royal Society of South Africa, October 20.—Dr. J. D. F. Gilchrist, president, in the chair.—Dr. J. D. F. **Gilchrist**: Observations on living fish brought by H.M.S. *Challenger* from tropical East Africa to Cape waters. In January, 1919, H.M.S. *Challenger* brought six species of fish from Dar-es-Salaam, Port Amelia, Mnazi Bay, and Zanzibar, which were transferred to the tanks of the Government Marine Station at Simon's Bay. They throve very well until April 25, when they all died within a few days of each other. At this date there was a sudden fall in the temperature of the water. The significance of this occurrence in connection with the distribution of fish in South Africa is discussed. Some observations were made on the sleeping habits of *Balistes aculeatus*.—L. **Simons**: Detection of induced β-ray emission from substances exposed to Röntgen rays by a photographic method. A narrow beam of Röntgen rays from a Coolidge tube impinging on a film of red lead laid down on paraffin wax gives a marked effect on a photographic plate placed opposite up to a distance in air of about 2 cm. from the red lead. If a photographic plate replaces the red lead, a similar, though less intense, effect is shown on the opposite plate. This excited radiation was almost stopped by the thinnest mica and paraffin wax. β-rays seem to be more important than secondary X-rays in producing a photographic impression.—J. R. **Sutton**: A contribution to the study of the rainfall map of South Africa. The monthly and annual rainfalls for 567 stations in South and East Africa are given, and the results shown graphically in thirteen maps. The isohyets form a system which moves to and fro across the equator, following the sun with a lag of a month or more. Corresponding with the general movements of the main isohyetal system are the winter rains of the south-west, which advance inland as the summer rains retreat and *vice versa*. The paper concludes with a short bibliography of special studies of South African rainfall.—J. R. **Sutton**: Some notes on ancient ideas concerning the diamond. Various prosaic "motives" for some of the legends and stories about the diamond current in ancient times are suggested. It is argued that Pliny, when he spoke of *adamas* as a name given to a crystal of gold, was probably referring to the outside appearance of the crystallisation.—F. G. **Cawston**: Experimental infestation of fresh-water snails. Infestation of *Limnaea natalensis* was caused by Fasciola from a sheep's liver, also infestation of *Physopsis africana* by water containing the miracidia of *Schistosoma haematobium*; here the mature cercariæ were found six weeks later.—R. D. **Aitken**: The water relations of the pine (*Pinus pinaster*) and silver-tree (*Leucadendron argenteum*). The conductivity of the wood for water, rate of transpiration, total area of leaf-surface, and sectional area of wood have been determined for similar twigs of pine and silver-tree. Under the experimental conditions pine leaves exerted a much greater suction force, calculated in one instance to be about four times that exerted by the silver-tree leaves. The latter are less able to resist drying than pine leaves, in which the rate of transpiration very rapidly diminishes when the twig is not supplied with water to a much lower level than in a silver-tree twig under identical conditions.—J. W. C. **Gunn**: The action of *Eucomis undulata*. *E. undulata* contains a large amount of a saooglucoside, soluble in water and 90 per cent. of spirit. It is a powerful hæmolytic agent. Absorption of the extract from the stomach and intestines and from the subcutaneous tissues is very slow; intravenous injections are actively poisonous, and produce symptoms like other saponin bodies.—T. J. **Mackie**: A study of the *Bacillus coli* group, with special reference to the serological characters of these organisms. The paper is a detailed record of investigations on the *B. coli* group with reference to their (1) biological classification, (2) serological characters, and (3) mutations. The biological characters of 246 strains of gram-negative, aerobic, non-sporing, and non-liquefying glucose-fermenting bacilli (not including specific pathogens of this class) were studied. Four main subgroups could be recognised: (*a*) Gas-producing, indol-forming, and non-inosite-fermenting. (*b*) Gas-producing, non-indol-forming, and non-inosite-fermenting. (*c*) Gas-producing and inosite-fermenting. (*d*) Non-gas-producing (anaerogenes types). The serological characters studied were (1) the agglutination and (2) complement deviation reactions of immune sera to certain of the commoner varieties. These observations proved of great interest from the purely immunological point of view, and also threw some further light on the biological relationships of the various types of coliform bacilli. The comparative resistance of various types to brilliant green was correlated with the grouping determined by cultural and serological tests. Mutations among these organisms were investigated, and afforded some explanation of the great diversity of cultural types and of the high degree of specialisation in the serological characters of individual strains.—E. **Newbery**: Note on over-voltages. Over-voltage appears to be a function independent both of the gas liberated and of the metal in question, and completely determined by valency alone. Whether the valency of the gas is involved or not is still an open question, since all gaseous ions used were monovalent. The over-voltage compounds probably carry excess electrons, and the addition of each electron produces a definite increment in the single potential, which increment is dependent only upon the number of free valency electrons present in the atom of the electrode or ion of the over-voltage compound.

Books Received.

Manual of Tropical and Subtropical Fruits: Excluding the Banana, Coconut, Pineapple, Citrus Fruits, Olive, and Fig. By W. Popenoe. (Rural Manuals.) Pp. xv+474+xxiv plates. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 30s. net.

The Principles of Preventive Medicine. By Prof. R. T. Hewlett and Dr. A. T. Nankivell. Pp. viii+536. (London: J. and A. Churchill.) 21s. net.

Root Development in the Grassland Formation: A Correlation of the Root Systems of Native Vegetation and Crop Plants. By Prof. J. E. Weaver. (Publication 292.) Pp. 151+plates. (Washington: Carnegie Institution.)

The New Physics. By Dr. A. C. Crehore. Pp. xii+111. (San Francisco: *Journal of Electricity*.) 2 dollars.

Physics of the Air. By Prof. W. J. Humphreys. Pp. xi+665. (Philadelphia: J. B. Lippincott Co.) 5 dollars.

The Physico-Chemical Properties of Steel. By Prof. C. A. Edwards. Second edition. Pp. xii+281. (London: C. Griffin and Co., Ltd.) 21s. net.

The Platinum Metals. By A. D. Lumb. (Imperial Institute Monographs on Mineral Resources.) Pp. ix+63. (London: J. Murray.) 3s. 6d. net.

Das Naturbild der Neuen Physik. By Prof. A. Haas. Pp. v+114. (Berlin and Leipzig: W. de Gruyter and Co.) 4.05 schill.

The Northern D'Entrecasteaux. By D. Jenness and the late Rev. A. Ballantyne. Pp. 219. (Oxford: Clarendon Press.) 12s. 6d. net.

The Progress to Geography. Edited by Dr. R. Wilson. Stage iii.: Myself and my Country: A Study in Civic Geography. Pp. 224. 3s. 6d. Stage iv.: The British World. Pp. 256. 4s. (London: Macmillan and Co., Ltd.)

Recent Advances in Organic Chemistry. By Prof. A. W. Stewart. Fourth edition. Pp. xvi+359. (London: Longmans, Green and Co.) 21s. net.

Department of the Interior. United States Geological Survey. Bulletin 597: Geology of Massachusetts and Rhode Island. By B. K. Emerson. Pp. 289+x plates. Professional Paper 96: The Geology and Ore Deposits of Ely, Nevada. By Arthur C. Spencer. Pp. 189+xv plates. Professional Paper 99: Chemical Analyses of Igneous Rocks. Published from 1884 to 1913 inclusive. By H. S. Washington. Pp. 1201. Professional Paper 111: The Ore Deposits of Utah. By B. S. Butler and others. Pp. 672+lvii plates. (Washington: Government Printing Office.)

La Chimie et la Vie. By G. Bohn and Dr. A. Drzewina. Pp. 275. (Paris: E. Flammarion.) 7.50 francs.

Laboratory Manual of the Technic of Basal Metabolic Rate Determinations. By Dr. W. M. Boothby and Dr. I. Sandiford. Pp. 117. (Philadelphia and London: W. B. Saunders Co.) 24s. net.

Advanced Lessons in Practical Physiology for Students of Medicine. By Dr. R. Burton-Opitz. Pp. 238. (Philadelphia and London: W. B. Saunders Co.) 18s. net.

A Course of Practical Physiology for Agricultural Students. By J. Hammond and E. T. Halnan. Pp. 106. (Cambridge: At the University Press.) 4s. 6d. net.

Girolamo Saccheri's Euclides Vindicatus. Edited and translated by Dr. G. B. Halsted. Pp. xxx+246. (Chicago and London: The Open Court Publishing Co.) 10s. net.

The Early Mathematical Manuscripts of Leibniz. Translated from the Latin Texts published by Carl Immanuel Gerhardt, with critical and historical notes by J. M. Child. Pp. iv+238. (Chicago and London: The Open Court Publishing Co.) 7s. 6d. net.

The Reversal of Halphen's Transformation. By H. E. J. Curzon. Pp. 15. (London: Constable and Co., Ltd.) 1s. net.

Dead Man's Plack and an Old Thorn. By W. H.

Hudson. Pp. vii+205. (London and Toronto: J. M. Dent and Sons, Ltd.; New York: E. P. Dutton and Co.) 7s. 6d. net.

Optical Methods in Control and Research Laboratories. Pp. 30. (London: Adam Hilger, Ltd.) 1s. 6d. net.

A System of Physical Chemistry. By Prof. W. C. McC. Lewis. (In 3 vols.) Vol. ii.: Thermodynamics. Third edition. Pp. viii+454. (London: Longmans, Green and Co.) 15s. net.

Department of Scientific and Industrial Research. Advisory Council. Report of the Lubricants and Lubrication Inquiry Committee. Pp. 126+3 plates. (London: H.M. Stationery Office.) 2s. 6d. net.

Department of Scientific and Industrial Research. Food Investigation Board. Special Report No. 4. Interim Report on Methods of Freezing Fish, with Special Reference to the Handling of Large Quantities in Gluts. Pp. 50+4 plates. (London: H.M. Stationery Office.) 1s. 6d. net.

Benzol: Its Recovery, Rectification, and Uses. By S. E. Whitehead. Pp. xiv+209. (London: Benn Bros., Ltd.) 12s. 6d. net.

An Educated Nation. By Basil A. Yeaxlee. (The World of To-day.) Pp. 80. (London: Oxford University Press.) 2s. 6d.

Never Grow Old: How to Live for more than One Hundred Years. By Dr. L. H. Goizet. Pp. 191. (New York and London: G. P. Putnam's Sons.) 10s. net.

Zoology: An Elementary Text-book. By Sir A. E. Shipley and Prof. E. W. MacBride. Fourth edition. Pp. xx+752. (Cambridge: At the University Press.) 20s. net.

Countryside Rambles. By W. S. Furneaux. Pp. lvi+186. (London: G. Philip and Son, Ltd.) 3s. 6d. net.

Psychology and Mystical Experience. By Prof. J. Howley. Pp. xi+275. (London: Kegan Paul and Co., Ltd.; St. Louis, Mo.: B. Herder Book Co.) 10s. 6d. net.

Mineralogy: An Introduction to the Study of Minerals and Crystals. By Prof. E. H. Kraus and Dr. W. F. Hunt. Pp. xiv+561. (New York and London: McGraw-Hill Book Co., Inc.) 27s.

Geology of the Non-Metallic Mineral Deposits other than Silicates. By A. W. Grabau. Vol. i.: Principles of Salt Deposition. Pp. xvi+435. (New York and London: McGraw-Hill Book Co., Inc.) 30s.

Diary of Societies.

THURSDAY, DECEMBER 16.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—H. Ricardo: Possible Developments in Aircraft Engines.—A. J. Rowledge: The Instalment of Aeroplane Engines.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—E. J. Prior: Some Sources of Error in Alluvial Boring. —R. E. Palmer: Some Observations on Mining by the Opencast or Stripping Method.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Discussion: Report on the Heating of Buried Cables.

CONCRETE INSTITUTE, at 7.30.—H. J. Deane: Special Applications of Reinforced Concrete in Docks, with Special Reference to the Reinforced Concrete Gates at Tilbury Docks.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at 28 Victoria Street), at 8.—T. E. B. Whiting: Carburation.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Sir R. Robertson: Lecture: Some Properties of Explosives.

RÖNTGEN SOCIETY (in Physics Lecture Theatre, University College), at 8.15.—The Reduction of Radiographic Exposures to 1/25th and Less by Means of a New Type of X-Ray Plate. Part I. by Dr. L. Levy and D. W. West. Part II. by T. Thorne Baker.

HARVEIAN SOCIETY OF LONDON (at 11 Chandos Street, W.), at 8.30.—Dr. C. M. Wilson, Dr. C. Buttar, and Others: The Future of the Poor-law Infirmary.

FRIDAY, DECEMBER 17.

SOCIETY OF MEDICAL OFFICERS OF HEALTH (at 1 Upper Montague Street), at 5.—Lt.-Col. H. R. Kenwood: Presidential Address to the Navy, Army, and R.A.F. Hygiene Group of the Society.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Dr. W. J. Walker: Thermodynamic Cycles in Relation to the Design and Future Development of Internal-combustion Motors.

JUNIOR INSTITUTION OF ENGINEERS (at Royal United Service Institution), at 7.30.—Lord Weir of Eastwood: Some Reflections on our Industrial Situation (Presidential Address).

ROYAL SOCIETY OF ARTS, at 8.—Col. R. J. Stordy: The Breeding of Sheep, Llamas, and Alpacas in Peru, with a view to supplying Improved Raw Material for the Textile Trades.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Adjourned Discussion: Radio-Therapy.—Dr. R. Morton: Recent Developments in Deep Therapy.—Dr. L. Martindale: Technique of X-ray Therapy of Fibroids.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at London School of Tropical Medicine), at 8.30.—Laboratory Meeting.

SATURDAY, DECEMBER 18.

PHYSIOLOGICAL SOCIETY (at St. Thomas' Hospital), at 4.

MONDAY, DECEMBER 20.

SURVEYORS' INSTITUTION, at 7.—H. S. Logsdon: Rating as affected by Recent Legislation.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street), at 8.—Prof. T. P. Nunn and Prof. H. Wildon Carr: Discussion on Prof. Alexander's "Space, Time, and Deity."

ROYAL SOCIETY OF ARTS, at 8.—A Chaston Chapman: Micro-organisms and Some of their Industrial Uses (Cantor Lecture).

INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates' Meeting) (at 28 Victoria Street), at 8.—W. H. Wardall: Cylinder and Piston Wear.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—F. Debenham: The Future of Polar Research.

TUESDAY, DECEMBER 21.

ROYAL SOCIETY OF MEDICINE, at 5.—General Meeting of Fellows.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Dr. D. J. Reid: Further Developments in Systematic Exposure in Photomicrography.

CONTENTS.

NATURE

THURSDAY, DECEMBER 23, 1920.

Editorial and Publishing Offices:
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The Dyestuffs Bill.

THE Dyestuffs (Import Regulation) Bill passed its third reading in the House of Commons on December 17 by a majority of 86 (111 votes to 25), after the Opposition had unsuccessfully challenged a division on the Government's motion to exempt the measure from the limitations of the Standing Order relating to a Friday sitting. This action on the part of the Opposition is an indication of the attitude of a certain section of the Manchester school of political economists towards the Bill; in so far as it savours of Protection, it is, of course, anathema. Their ears were apparently deaf to all arguments as to the absolute necessity of resuscitating, as much in the interests of our national security as in those of our commercial prosperity, an industry primarily of British origin. The old theoretical Free Trade arguments against the Bill failed, however, to convince all Free Traders in the House. The member for the Bridgeton division of Glasgow, as a Free Trader, had the temerity to denounce the agitation against the measure as wholly factious and bogus and as doing the greatest harm to the cause of Free Trade.

A perusal of the proceedings of Standing Committee B, which was charged with the consideration of the Bill, serves to confirm this impression. Under cover of protecting the interests of the textile and other colour-using industries, an amendment was moved which, without materially benefiting these industries, could only result in limiting the beneficent intention of the Bill as regards the dye-makers. The mover of the amendment scored one or two debating points, but the suggestion to add words to the particular subsection which prohibits importation of dyestuffs so as to imply that the safeguarding of the dye-making industry was being done at the expense of the textile industries so little commended itself to the judgment of the Committee that it was rejected by a majority of more than two to one. Such action on the part of the Opposition is not constructive legislation. There is no necessary antagonism between the colour-makers and the colour-users in this country; their mutual interests are inseparable, and the prosperity of one section is bound up with that of the other.

The same animus against the measure was displayed in a succession of amendments which were ruled out of order. Attempts were next made to restrict the prohibition to dyestuffs manufactured in Germany, but, as the Parliamentary Secretary to the Board of Trade pointed out, to confine the clause to the prohibition of importation from Germany would make the Bill perfectly nugatory. To safeguard the dyestuff industry effectually, it had to be safeguarded against competition from all outside sources. Moreover, there would be nothing to prevent the German dye-makers from establishing depôts in other countries and exporting the dyes thence. A moving appeal was made on behalf of Switzerland, which, it was contended, had continued to help us throughout the war, and, it was added, incidentally to help herself. To what extent Switzerland made herself an agent for the transmission of German-made dyes was not stated.

This character of argument was too much for the patience of some members of the Committee. Sir Philip Magnus, the member for the University of London, bluntly charged members of the Committee with the deliberate intention of obstructing the Bill; from the speeches at the first sitting it was obvious that every possible opposition would be made. This unmasking of their batteries was naturally warmly resented by the militant members, led by Major Barnes, Col. Williams, and Major Hayward, who protested, in the words of Major Wood, that they were "not out against protecting or assisting the dye industry." What they objected to were the means by which that end was to be reached. But whatever affection they might feel towards the dye industry was most effectually dissembled. In the end the attempt to restrict the prohibition to Germany was defeated by a majority of nearly three to one. Later attempts to leave out the provision as to colours and colouring matters and organic intermediate products; to direct the Advisory Committee as to the grounds of their decisions; and to provide that "prohibition shall not apply to any such goods manufactured within the British Empire," were either abandoned or were defeated by large majorities on division. A similar fate met amendments raising the question of the date of the application of the Act; the prohibition of synthetic organic products imported mainly for medical purposes; and the importation of new colours.

The longest discussion occurred on the question of the composition and functions of the Advisory Committee which the Board of Trade is empowered to set up for the purpose of advising it with respect to the granting of licences. This Committee is to consist of five persons concerned with the trades using dyestuffs, three persons connected with their manufacture in Great Britain, and three persons constituting "a neutral body"—that is, persons not directly concerned with the manufacture or use of dyestuffs—one at least of whom is to possess "high scientific qualifications"—not, as one Opposition amendment suggested, "a person of medical skill," although why such a person is needed on such a Committee is not very obvious. Various attempts were made either to enlarge the Advisory Committee or to place upon it representatives of particular trades, such as the export branches of the textile industries, the woollen and worsted industry, and the cotton industry. Nor were the claims of Labour, as such, forgotten. But the President of the Board of Trade, who throughout the four days' proceedings had discharged his responsibilities with urbanity and tact, firmly resisted all attempts to tamper with the constitution and functions of the Advisory Committee as defined in the Bill, and in the end, after repeated divisions, in which the malcontents were defeated by increasing majorities, he got his way.

As a last resource, the Opposition sought to curtail the operation of the Act. It is provided that the Act shall continue in force for a period of ten years and no longer. Successive amendments were moved to limit it to one year, then to three, next to seven years; but after the closure had been carried it was decided that the words proposed to be left out should stand part of the clause, and ten years is to be the duration of the Act, which, as afterwards stated by Sir Robert Horne, is to come into force on January 15 next. Major Wood then moved that the Act shall cease to be in force if an Order in Council, on an address by both Houses of Parliament, should so determine; but the amendment was declared to be out of order. An Act of Parliament can be repealed only by an Act of Parliament.

The debate in the House on the Report stage of the Bill was to a large extent a repetition of the proceedings of the Committee. Clauses were moved to limit the extent of prohibition on the import of dyestuffs; to limit dividends and profits by manufacturers of synthetic colouring matters; to curtail the currency of licences; and to alter the constitution of the Advisory Committee; but, after repeated applications of the closure, these several amendments were defeated by even larger proportional majorities than they had met with in the Standing Committee.

On the third reading a last despairing effort was made to reject the Bill, but the appeal to Cæsar met with no success, and the twenty-five stalwarts were beaten by a majority of nearly five to one.

The Meteorology of the Antarctic.

British Antarctic Expedition, 1910–1913. *Meteorology:* Vol. i., *Discussion.* By Dr. G. C. Simpson. Pp. x+326+v plates. Vol. ii., *Weather Maps and Pressure Curves.* By Dr. G. C. Simpson. Pp. 138+23 plates. (Calcutta: Thacker, Spink, and Co., 1919.)

It was a fortunate day for meteorology when Capt. Scott invited Dr. Simpson to join his last expedition as meteorologist. The Antarctic has always provided a fascinating field on account of the symmetry of its general circulation combined with remarkable local phenomena; but never before has a meteorologist and physicist of the first rank studied Antarctic meteorology on the spot and presented to the world the digested results of observations planned and executed by himself.

The two volumes now published contain a comprehensive discussion of Antarctic meteorology in 1911–13, and a series of weather maps at 8 a.m. and 8 p.m. daily (presumably 180th meridian time) from April 1 (1911?) to January 2 (1912?), a period of nine months. A third volume will include detailed tables of the results of observation. The printing was done in Calcutta and is good, but the registration of the synoptic charts is frequently indifferent.

In a brief preface tribute is fittingly paid to the people of Derby for the provision of funds for instruments and to the other members of the expedition for indispensable assistance in maintaining the records; the author proceeds modestly to disclaim ability or interest in statistical meteorology; nevertheless, the book abounds in means and averages, frequency curves and Fourier coefficients, correlations and probable errors, and dispels, by its completeness, the suspicion engendered by pp. vi and vii of the preface that the author was approaching his task under the impression that the function of meteorology was to "attempt" the questions of a Saturday morning problem paper rather than to record facts and to set them in order for the information of mankind.

The observations on which the discussion is based were made at the base stations Cape Evans and Cape Adare, at Framheim (Amundsen), and for shorter periods at different places on the Barrier and the plateau by the various parties. Two very instructive maps in the introductory chapter show the surroundings of Cape Evans and Cape Adare, and indicate that the situation of neither station was very good from the meteorological point of view: an indication which is supported by the records of wind. At Cape Evans 43 per cent. of the winds were below ten miles per hour, and the direction of the wind bore so little relation to the general distribution of pressure that on a large number of occasions it appeared to be blowing *out* of the centre of low pressure. At Cape Adare, the northern extremity of a promontory twenty miles long, 72 per cent. of the winds were below five miles per hour, whereas at a well-exposed station in the British Isles only about 10 per cent. of the winds come into this category; and in a similar situation further west in the Antarctic Mawson found an average wind speed for the year of fifty miles per hour.

The main discussion is divided into nine chapters dealing with temperature, wind, cloud and precipitation, pressure and its relation to winds and weather, general circulation, the upper air, the height of the Barrier and the plateau, and atmospheric electricity. Each chapter contains not merely a discussion of the results of the observations and a rational explanation of the facts revealed, but also some new contribution (such as, for example, a study of the gustiness of the wind) which was rendered possible only by the new instruments and methods not previously available in Antarctic work.

The annual and diurnal variations of temperature are shown to be, on the whole, due to insolation, but two features present difficulty. There is a diurnal variation of temperature during the months when the sun is completely below the horizon, and the "day" hours are, on the whole, warmer than the "night" hours. No rational explanation is given of this effect. The suggestion that it arises from scattered radiation from the upper layers of the atmosphere which come into the sunshine during the "day" hours is not mentioned, and it appears to be excluded by the fact that the effect is more marked on cloudy than on clear days, and by the further fact that on clear days there are two maxima at about 4 a.m. and 4 p.m., the time of minimum pressure in the semi-diurnal barometer oscillation. The unusual feature in the annual variation is roughly this: on the Barrier the amplitude of the variation is "oceanic" and the phase "continental," while in the Arctic the amplitude is "continental" and the phase "oceanic." The explanation put forward is, roughly, that the continents of Asia and America control the amplitude in the Arctic Ocean, and the Antarctic Ocean controls the amplitude on the Barrier; the argument is well stated, but it is not entirely convincing.

The records from the Dines pressure tube anemometer, many of which are reproduced, add greatly to the interest of the chapter on wind, and, indeed, to that on temperature, too, by the light they throw on blizzards and other sudden changes. The winds at Cape Evans were found to be about 50 per cent. more gusty than the winds at Scilly and Holyhead; but the gustiness decreased as the speed of the wind increased, indicating, according to Dr. Simpson, that the high value was due, not to the exposure, but to the interaction between a warm upper current and a cold surface layer which are co-existent in the Antarctic more frequently than in England.

Pressure-waves travelling outwards from the centre of the continent are Dr. Simpson's contribution to the explanation of the synoptic charts of the Antarctic. He rejects Lockyer's scheme of travelling cyclones, and pours scorn on the suggestion that the motion of the air in a blizzard is part of a very large cyclonic system. "A depression with its centre in 60° S. able to produce a blizzard of 40–60 miles per hour in 78° S. is of course quite inconceivable. Whatever blizzards may be due to, they are certainly not part of the circulation around a cyclone the centre of which is more than 1000 miles away." He appears here to be doing less than justice to Lockyer's scheme, which may represent the broad features of the pressure distribution, even although all the cyclones do not adhere rigidly to the 60th parallel of latitude.

The theory of pressure-waves will undoubtedly provoke much discussion; facts are marshalled in an imposing array to support it, and theoretical synoptic charts are produced which are wonderfully similar to the charts based upon actual observations. The pressure-waves are apparently not sound-waves; they are described as "true pressure-waves traversing the upper atmosphere in the same way that water-waves travel across the sea"—*i.e.* they are waves formed at a surface of discontinuity. As the waves appear to be at least 500 miles from crest to trough, there cannot be very many of them—probably, in fact, not more than one—in existence at a time, so that the comparison ought to be with one long wave in shallow water (*e.g.* a tidal wave) rather than with "water-waves travelling across the sea"; it appears doubtful if it is possible at the surfaces of discontinuity, which certainly exist in the Antarctic, to get waves 500 miles long travelling at forty miles per hour, and having pressure amplitudes of 20 millibars at sea-level. The horizontal transference of a large mass of air naturally suggests itself as an alternative explanation, but the adjustment of the motion to the pressure gradient presents difficulties.

In his discussion of the general circulation Dr. Simpson arrives at conclusions agreeing in some respects with Hobbs, and in others with Meinardus. Broadly speaking, he makes the whole continent an anticyclonic area surrounded by a broad band of low pressure about lat. 65; but at 10,000 ft. the plateau alone is anticyclonic, while a very marked cyclone is centred over the part of the Antarctic which is near sea-level. The upper winds deduced from cloud observations and from Erebus's smoke fit in well with the scheme.

The free atmosphere over the Antarctic had never been explored before Dr. Simpson sent up his *ballons-sondes*; the results of this first attempt are remarkably good, although the stratosphere was not reached. Out of twenty-one ascents, fourteen instruments were recovered, of which twelve furnished good records; but three of them referred to different times on one day, November 19, 1911. In six cases of summer ascents the temperature decreased steadily upwards at a rate of about 6° C. per kilometre; in four cases of winter ascents temperature rose at the commencement of the ascent, and began to fall only after a height of one or two kilometres had been reached. The lowest temperature recorded in these ascents was $-46°$ C. ($-51°$ F.) at a height of 6750 m. (22,000 ft.) on Christmas Day, 1911. The lowest temperature recorded on the Barrier was $-60°$ C. ($-76°$ F.) on July 6, and this is the lowest temperature recorded anywhere in the Antarctic.

The observations on atmospheric electricity led to interesting conclusions on the effect of drift-snow, which, however, could not be put to the crucial test owing to Dr. Simpson's unexpected recall to India. One is, indeed, forced to observe that the Government of India was decidedly less than generous throughout. It might well have lent Dr. Simpson's services in such a glorious cause, seeing that a proper knowledge of Antarctic meteorology is vital to an understanding of those great currents of the atmosphere to which monsoons belong; instead, it granted him "leave without pay," and then recalled him in the middle of the enterprise.

The work is a notable contribution, not merely to Antarctic meteorology, but also to meteorological science; it is an enduring monument to the great leader of the expedition through whose foresight and scientific spirit the enterprise was made possible.

Imperial Mineral Resources.

(1) *Imperial Mineral Resources Bureau. The Mineral Industry of the British Empire and Foreign Countries. War Period. Arsenic.* Price 6*d.* net. *Felspar.* Price 6*d.* net. *Chrome Ore and Chromium.* Price 1*s.* net. *Fuller's Earth.* Price 6*d.* net. *Magnesite.* Price 1*s.* 3*d.* net. (London: H.M. Stationery Office.)

(2) *Tungsten Ores.* By R. H. Rastall and W. H. Wilcockson. (Imperial Institute: Monographs on Mineral Resources, with Special Reference to the British Empire.) Pp. ix+81. (London: John Murray, 1920.) Price 3*s.* 6*d.* net.

(1) THE necessity for complete and accurate information about the mineral resources of the British Empire has repeatedly been emphasised in these columns and elsewhere. Even before the war this need had become evident, and it was felt to be a serious reflection upon British statisticians that the most trustworthy source of such information was to be found in an American publication. During the war, the gravity of this deficiency naturally became accentuated, and the formation of the Imperial Mineral Resources Bureau has been the result. This bureau has now been organised, and is entering seriously upon its labours, the result being made public in the form of a succession of pamphlets, each dealing with one particular mineral. Those hitherto issued relate to minerals of relatively minor importance, and include arsenic, felspar, chrome ore and chromium, fuller's earth and magnesite. The

scheme of all these pamphlets is identical; they commence with a general description of the mineral discussed, its composition, uses, and chief sources of supply. The world's output of the mineral is then given, and this is followed by a detailed description of the occurrences in the United Kingdom and the rest of the British Empire, together with statistics of production, followed by similar information concerning foreign producers. References to technical literature on the subject are given in an appendix, and in some cases there is an additional note on some important application of the mineral; for instance, the pamphlet on magnesite contains a note on the production of magnesium chloride and its use in the manufacture of Sorel cement. It should be added that the statistics and information relate in each case to the "war period," 1913-1919. These publications thus form a continuation of those formerly issued by the Home Office, and known as part iv. of the Report of the Chief Inspector of Mines. It would probably have been more convenient for most users of these pamphlets if the statistics had been taken rather further back, and given, say, for the last ten years, and if decennial tables were included in all future annual issues. There is some information as to costs and prices, though not sufficient for those interested in the industries, but no doubt in future years these figures will be given in more detail; it is also stated that in future issues data concerning labour, safety, etc., will be included.

The work of compilation has been well and carefully done, upon the whole; it would be easy to point out small errors and omissions, but these are inevitable in the first issue of a publication of this kind, which involves a vast amount of minute and painstaking research amongst a large number of different sources of information, which are often of very unequal value so far as trustworthiness is concerned. Perhaps the least satisfactory feature is the fact that a number of different standards of weight are employed; it is true that a footnote points out that metric, long and short tons are employed, and the equivalent of each of these is given, but this is not quite enough; it should not be necessary for anyone using these pamphlets to make a calculation before he can compare the statistics that he finds on adjoining pages; probably the best plan is to give in every case the tonnages as reported in the original source of information, and in a parallel column these weights in metric tons, which latter are being largely employed by scientific statisticians.

(2) Simultaneously with the issue of these publications by the Imperial Mineral Resources Bureau, the Imperial Institute has issued another volume of its series of monographs on mineral resources, the present one being on tungsten ores, written by Messrs. R. H. Rastall and W. H. Wilcockson. In its general scheme this pamphlet is identical with those produced by the Imperial Mineral Resources Bureau, and its execution is quite satisfactory, though perhaps the economic aspect of the subject receives even less attention here than in the other series of publications. The question that evidently obtrudes itself, however, is whether there is anything at all gained by this duplication of effort. The issue seems to be unusually simple; the Imperial Mineral Resources Bureau has been organised, and is maintained out of public funds for doing just the very work that the Imperial Institute is taking up. If the bureau does not do its work completely and efficiently, it should be called upon to mend its ways; but if it does do the work entrusted to it satisfactorily, it is surely to the public interest that the Imperial Institute should employ the funds entrusted to it in some more useful manner than in duplicating this work, and it cannot be suggested that there are not plenty of other important Imperial problems needing investigation.

H. LOUIS.

New World Zoology.

Zoölogy: A Text-book for Colleges and Universities. By Prof. T. D. A. Cockerell. (New World Science Series.) Pp. xi + 558. (Yonkers-on-Hudson, New York: World Book Co., 1920.) Price 3 dollars.

TEXT-BOOKS of zoology are legion, and they are by no means all bad. Some of them, indeed, like "Marshall and Hurst," are almost perfect specimens of their kind. Yet we can understand the growth of the list, for every experienced professor of the science has his optimistic moments when he thinks that his particular way of teaching the subject is worthy of presentation to an audience wider than that in his classroom. But the unfortunate fact seems to be that few writers of text-books have managed to fulfil their intention. In many cases the individuality ends with the preface, the whole book sinking to conventional competence on familiar lines.

But this is not true of Prof. Cockerell's "Zoölogy," for it has an individuality. "The biology or zoology for the average individual who has no thought of specializing in the department should not be too morphological, too rich in detailed facts of structure and classification. Experience shows that such minutiæ are not remembered, and do not necessarily leave as a residue any broad and useful conceptions." So the author has space for many interesting stories, which are crowded out of most books, such as Mendelism, "linkage" and "crossing over," artificial fertilisation, Protozoa and disease, social insects, the pedigree of the elephant, and the zones of life.

Another feature is the insistence on practical utility, not in any tiresomely narrow way, but with a wide horizon. Zoology is for life, not life for zoology. There are big ideas to be understood, which will influence the whole conduct of life. Most of these big ideas are difficult, but "from a psychological and pedagogical standpoint, it is surely an error to suppose that each idea must be luminously clear at the moment of presentation." Prof. Cockerell gives his students plenty to ponder over, for he deals with the living substance, the individual, "nature" and "nurture," alcohol and heredity, variation, selection, disease in relation to human evolution, eugenics, and sociology from a biologist's point of view. The chapters are freshly written, very objective, and their brevity is as psychologically sound as it is unusual. The author does not preach at all, but he suggests the responsibility as well as the happiness of playing the scientific game. He also suggests the wonder of the world. So it is not a common text-book this; it is a new presentation.

A third feature of great value is the introduction of biographical chapters. "We are too apt to receive the gifts of science without asking whence they came. . . . As the pious studied the lives of the saints, so may we pause now and then to learn how scientific heroes have won new territory for the kingdom of science. Thus, if we have anything of generous response within us, we may return to our studies refreshed, resolving that we also, in some measure, will further the good cause." So the book contains sketches of Darwin, Mendel, Linnæus, Fabre, Pasteur, and others. There are numerous illustrations, many of them new and interesting, others a little too familiar. For the general student who is not going to pursue zoology far, this is an admirable text-book; for all it is a good introduction.

The Botany of Iceland.

The Botany of Iceland. Edited by Dr. L. Kolderup Rosenvinge and Dr. Eug. Warming. Vol. ii., part i. By Ernst Østrup and Olaf Galloe. Pp. 248+5 plates. (Copenhagen: J. Frimodt; London: John Wheldon and Co., 1920.)

THE present instalment of the results of work on the botany of Iceland is devoted to the Cryptogamic flora, and contains an account of the fresh-water diatoms by the late Dr. Ernst Østrup, and a description of the lichen flora and lichen vegetation by Dr. Olaf Galloe. The former comprises a systematic list of species based on the examination of 572 samples collected by different botanists in various parts of the island. The list includes a number of new species and varieties which are figured in the five plates. The author also gives a table indicating the general distribution, and the distribution in the different parts of Iceland, of the 468 forms listed. From this table it appears that 95 per cent. of the Icelandic forms also occur in the rest of Europe; Asia and America come next with about 50 per cent.; comparing Iceland with the Arctic regions, the greatest resemblance is with Greenland, with which it has 41 per cent. in common. A classified list is also given of the species found in hot springs from thirteen localities.

Dr. Galloe's account of the lichenology of the island is based mainly on observations made by himself during the summer of 1913, when he investigated fairly thoroughly several of the coast districts, although he had no opportunity of examining the desert interior of the island. The author criticises the methods of systematic lichenologists, who have endeavoured to diagnose species on lines similar to those followed in dealing with flowering plants. This, he maintains, has led to the establishment of a large number of species, many of which would probably be shown by culture experiments to be forms of one and the same species. Unfortunately, this experimental method would be difficult and tedious, and there is little hope of its being successfully carried out. In the meantime it is urged that lichenologists should publish extended descriptions of "one single individual" of each type in order to leave no doubt as to the form which it is intended to describe.

A classified list of the species is given, but the greater part of the work deals with the biological and ecological aspect of the lichen flora. The means of propagation and of dispersal of the Iceland lichens are discussed, and an account is given of the chief biological conditions in which they occur. They are classified under three associations—the bark-lichen, the earth-lichen, and the rock-lichen. The conclusion is drawn that Iceland (like other Arctic countries) is poorer in species according to its area than temperate and subtropical countries, but as regards frequency-number and abundance the Arctic regions and Iceland are probably richer than other regions. No doubt this is chiefly on account of the slight competition to which the lichens are subjected.

Our Bookshelf.

Scientific and Applied Pharmacognosy. By Prof. H. Kraemer. Second edition, thoroughly revised. Pp. xxviii+741. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) Price 33s. net.

OF all the American works on pharmacognosy, none is so well known in this country as Prof. Kraemer's, and every pharmacognosist will welcome the appearance of a second edition as affording the author an opportunity, of which he has taken full advantage, of increasing the scope of the work and bringing it up to date. In nearly all the descriptions of the drugs the inner (microscopical) structure is included, and also the characters of the powder; more attention has been devoted to the chemistry, and, in the case of those containing important alkaloids, glucosides, or other definite constituents, these are very fully described and characterised. Many of the numerous illustrations are original, particularly those of the sections and the microscopical characters of the powders, the value of which, it must be confessed, would have been enhanced by a statement of the magnification. Pyro-analysis of drugs, carried out by examining sublimates obtained at comparatively low temperatures, to which a good deal of time has been devoted on the Continent during the last few years, has also received attention, although most pharmacognosists will probably agree that its real value has still to be proved. The section on animal drugs is very interesting, particularly the description of cochineal. In the tables arranged for the identification of a powdered drug, the author still adheres to a primary classification based upon the colour, although this has not found general acceptance.

The work is well printed and freely illustrated; it contains a mass of information, much of which is not otherwise readily accessible; and it should therefore find a place in the library of every pharmacognosist.

The Groundwork of Modern Geography: An Introduction to the Science of Geography. By Dr. A. Wilmore. (Bell's Geographical Series.) Pp. xv+396+xxvii plates. (London: G. Bell and Sons, Ltd., 1920.) Price 6s. net.

AMONG text-books of geography this volume is noteworthy, because it has a fresh outlook and strikes new ground, the author having the courage to depart from many of the time-honoured conventions of school geography. The subject is divided into three parts—structural, climatic, and biological geography—the last rightly including the elements of human geography. Economic considerations are kept well to the fore, which helps to dispel the fallacy of regarding economic geography as a distinct subject.

There is here no medley of scraps of geology and meteorology, but a true geographical treatment of land-forms and climate. The only fault we have to find with the sections on climate and vegetation is that in their brevity they tend to overlook causal relations, and lapse at times into mere descriptions. These chapters might well have been extended by the sacrifice of the chapter on the distribution of animals, a subject that in most of its aspects is not required in the geographical synthesis, since comparatively few wild animals directly influence human activities and migrations. The absence, on the other hand, of any notice of the distribution of disease-bearing insects is a serious omission. Useful bibliographies are given to all chapters, and there are some well-chosen illustrations. R. B.

A Course of Modern Analysis: An Introduction to the General Theory of Infinite Processes and of Analytic Functions; with an Account of the Principal Transcendental Functions. By Prof. E. T. Whittaker and Prof. G. N. Watson. Third edition. Pp. vii+608. (Cambridge: At the University Press, 1920.) Price 40s. net.

THE first edition of this admirable and well-known treatise was the single-handed work of Prof. Whittaker, and was published in 1902. Into the second edition, which was published thirteen years later and reviewed in NATURE for June 8, 1916, the results of Prof. Watson's collaboration entered very largely. The scope of the work was then considerably extended. The present, or third, edition appears at a much shorter interval, and contains fewer changes, chiefly represented by corrections and a fuller apparatus of references. But a valuable chapter on ellipsoidal harmonics is an entirely new feature. This fine work is now far larger and more complete than in its original form, and it is inevitable in present circumstances that the price has been considerably advanced. The only complaint that can be suggested in this connection is that, at the high price, paper of a rather better quality might have been provided.

Medical Electricity: A Practical Handbook for Students and Practitioners. By Dr. H. Lewis Jones. Eighth edition. Revised and edited by Dr. L. W. Bathurst. (Lewis's Practical Series.) Pp. xv+575. (London: H. K. Lewis and Co., Ltd., 1920.) Price 22s. 6d. net.

THE seventh edition of this valuable treatise on medical electricity was reviewed in NATURE for June 20, 1918. Since that date the subject has expanded in various directions; the war provided a mass of new material for electro-therapeutists, and in the present edition indications of these advances have been inserted. The effects of Röntgen rays are dealt with in discussing physiological and pathological considerations, but there is no mention of the technical apparatus used in this work, for the reason, as Dr. Bathurst states in his preface, that "Röntgenology" is now a separate department of medical work. A chapter on ultra-violet radiation, and new matter relating to ionisation, diathermy, and the electrical testing of muscles, have been incorporated in the text.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Heredity and Acquired Characters.

ALTHOUGH agreeing entirely with Sir Ray Lankester's and Prof. MacBride's criticisms (NATURE, December 16, pp. 500–1) of Sir Archdall Reid's letter, I venture to add a few words on two points.

First, I will attempt to explain to Sir Archdall Reid why it is held that a head is "more innate and germinal and less acquired and somatic than a scar" (*ibid.*, November 25, p. 405).

It is reasonable to suppose that, at least up to hatching, the nurture of the chicks of all domestic races is the same. The differences between their heads are therefore due, not to nurture, but to nature. Nurture is an essential condition of their development, but, being uniform, it cannot be a cause of diversity.

A scar is the precise opposite of this. Its cause is the blow or other external force inflicting injury, an essential condition being the existence of organic matter incapable of resisting the force and with limited powers of regeneration. This condition is uniform over a large part of the body surface, and can never explain the infinite variety in the appearance and position of scars.

We therefore rightly maintain that everything distinctive of the normal head, everything which we can describe, measure, or figure, is *inherent* or *blastogenic*, although appropriate external conditions are necessary for its development; and that, similarly, every feature by which one scar is distinguished from another is *acquired* or *somatogenic*, although germinal potentialities are necessary for its existence.

One other consideration arises out of Sir Ray Lankester's letter. Although I entirely agree that acquired characters are commonly "departures (either increase or decrease) from the usual or normal size, form, or structure of this or that part," yet—as I pointed out in reply to similar definitions by Sir Francis Galton and Prof. Lloyd Morgan—it is "a mistake to make too much of abnormality, or to import it into a definition. Some of the most marked, and certainly the most easily studied and tested, of acquired characters are the differences between the effects of alternative environments, all of which are normal, upon the individuals of a single species. The green colour of a larva of *Amphidasys betularia*, if fed upon broom, is an acquired character, as is the dark colour it would assume upon oak, etc. I think, therefore, that a more satisfactory definition of, at any rate, a large class of acquired characters may be framed as follows: 'Whenever change in the environment regularly produces appreciable change in an organism, such difference may be called an acquired character'" (Proc. Ent. Soc. Lond., 1904, p. cviii.).

EDWARD B. POULTON.

Oxford, December 19.

Environment and Reproduction.

SEVERAL attempts have been made to show that spawning in the sea and in fresh waters, and also in terrestrial conditions, is regulated by temperature. Many examples could be quoted to demonstrate that the rule is for a species to spawn earlier and to develop more quickly in warm water; that, in other words, the period of spawning is early in tropical seas and conditions, and later to the north and south of the tropical belt, and that the period of growth is increased with lowering of temperature. The factors at work, however, are more deep-seated than they appear to be at first sight. That this is so is at once clear from two correlated considerations: (1) There is a period, sometimes a long period, of ripening with reference to which spawning is the culmination, and during which somatic changes and migratory results are produced; and (2) all the adults do not participate in the ripening and spawning.

In the case of the Protista and the Metazoa which reproduce rapidly, an annual phase may be postulated which closely follows the rise and fall of temperature, but in each generation reproduction follows growth, and does not take place until the growth of the cell or of the soma has reached a certain condition. When the growth is represented by a curve the point of inflection may be said to mark the period when, in the case of the cell, the impulse is conveyed to prepare for division, and in the case of the Metazoon the call arrives to the gonad to develop. Now amongst the Metazoa we get all stages, from the rapid reproduction of such forms to those which reproduce twice a year or once a year, and to those which reach maturity after several years of growth and do not necessarily thereafter spawn annually. In each case we have to observe that the somatic need must be satisfied before maturation is introduced. There are aquatic and terrestrial species which in one situation reproduce once a year, and in warm seasons or in warmer situations reproduce twice a year. But we understand by that statement that the conditions have allowed the early generation to grow

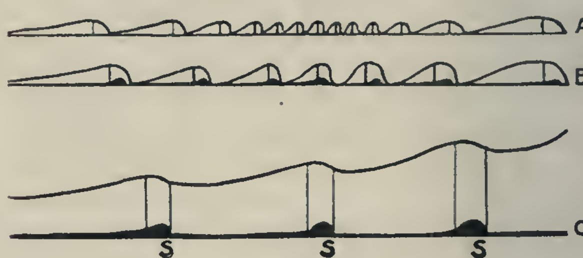

FIG. 1.

sufficiently fast to permit of a second generation in the same season.

In the accompanying diagrams (Fig. 1) an attempt is made to indicate the effect of summer and winter on Protozoa (A) and on Metazoa which have many generations a year (B). Lowering of temperature in these cases would restrict growth, and therefore the number of generations. The diagrams also depict the acceleration and retardation of growth and reproduction of planktonic species passing to and from tropical seas. In (B) the history of the gonad is indicated by the black curves. This is also done in (C), which is meant to show the periodical changes in a species which spawns regularly.

With regard to the last, we must first differentiate between the individual and the crowd. The spawning period may be a long one in the tropics, but it is periodic for the individual, and, indeed, spawning seasons are in many cases sharply indicated in tropical species of all groups. If, with reference to such an example as (C), the season of the commencement of maturation of the gonad be approximately constant, the effect of lowering of temperature would be manifested by a later spawning. Such considerations go, therefore, a long way to explain the observed results, and they also serve to explain the length of the tropical spawning season and the more restricted season of temperate, and especially of Arctic, regions. Without reference to other environmental factors, it may be granted therefore that growth and reproduction vary in length and periodicity with temperature. Nevertheless, the fact that the spawning season may be postponed makes us feel unsatisfied with an explanation which transfers in a general way, as, say, by the physical condition of the circulation, the function of intimating to the gonad that it can proceed with its development. Besides, the regularity of the spawning seasons, the manner in which summer and winter are impressed upon the most sedentary animals, the influence of warmth and density in promoting larval life, and other similar considerations, bring us back once more to the question of environment.

There may be said to be, as is shown in the accompanying diagrams, three phases of life in all animals: immaturity, maturity, and spawning. If the act of spawning is not followed by death, then there succeeds a series of similar phases. If we are prepared to recognise that the phase of immaturity is not ended alone by the attainment of the requisite somatic growth, then it is regulated by an organ which acts as an inhibitor of the next phase, and continues to act, not merely until the soma is in the requisite condition, but until the environment is also favourable. Such an organ must be placed in a convenient situation for receiving impressions from the environment and for communicating to the blood a hormone the function of which is to inhibit the development of the gonad. In the case of aquatic animals we naturally turn to the gills to see if such an organ is provided, and it is already apparent that the thymus has been developed for this purpose. The thymus is a larval organ which develops in association with the gills, and it is already known that its secretion inhibits the growth of the gonads. A thymus-like secretion will probably be found to be at work in this manner in all animals. In the Craniata the thymus is removed from its primitive position in the gills, but it lies near the gills of fishes, and in them and the higher Craniata continues to exercise its function of controlling the period of adolescence.

When the thymus ceases to supply its secretion to the blood the gonad commences its period of growth, and it is probably then that the thyroid comes into action to control in similar manner the growth of the gonad. The thyroid has an interesting history, and in the higher animals at least its relationship to the gonad has long been known. It is developed in the floor of the gill-chamber, and therefore is in a favourable position not only for helping in the straining of the food by the gills, but also for intimating to the blood the reception of the food, and even other environmental changes. The thyroid, then, probably controls the second phase; and if the thymus, so to speak, during the first is constantly intimating to the gonad that it is not time yet to commence growth, that the environment is not in the right condition, so can we imagine the thyroid controlling the degree of growth until temperature and other conditions are favourable for spawning. Both these ecological organs may be presumed to influence the growth of the soma according to the environmental changes. The gonad itself during its period of growth contributes messages to the blood which influence growth and produce migrations.

With these organs we have to associate the pituitary body, which arises from the ectoderm of the roof of the mouth, and the parathyroids, which are developed in the gills. The former appears to be very like the thyroid in function, and the latter are yet little understood. Until we know more of these organs it would be idle to speculate as to their primitive functions. The actions of such organs of the environment may tend to be automatic, as has been suggested, but it is probable that direct impulses are introduced producing adaptation to changes in salinity and temperature. For example, there are widely distributed species, but restricted to tropical and temperate seas, and others which with little or no modification manage to live in every kind of water from equatorial to Arctic. Many of the species, therefore, which have with great difficulty been differentiated amongst holoplankton will likely turn out to be more physiological than morphological in character.

We have yet a lot to learn from biochemical inquiry and from experiment as to these fascinating ductless glands. I have, in the meantime, tried to show that some of them are concerned in conveying impressions of the environment to the soma and to the germ-cells by a series of impulses carried by the blood, and leading to a primitive but effective internal and external integration. It is probable that reproduction in general in Protozoa, and in the cell as in Metazoa, is so controlled, and that such fundamental effects may have a profound pathological bearing.

Alexander Meek.

Armstrong College, Newcastle-upon-Tyne,
November 8.

Mode of Feeding and Sex-Phenomena in the Pea-Crab (*Pinnotheres pisum*).

The pea-crab which lives inside mussels, cockles, and sometimes even oysters, has been an object of general interest since the days of the Pharaohs, and many legends have been invented of the way in which it feeds and of its relation to its host. Calman gives an account ("The Life of Crustacea," by W. T. Calman, London, 1911, p. 217) of many amusing habits attributed to this crab by many writers. For instance, the pea-crab has been stated to warn its host of the approach of enemies or of the entrance of prey between its gaping valves, but it will be seen from what follows that the bivalve and crab depicted in Egyptian hieroglyphics to symbolise the dependence of man on his friends is indeed an appropriate symbol.

A search of modern literature, however, reveals that only vague accounts exist of the manner in which this crab feeds and lives. Recent work on the mode of feeding in bivalve molluscs and other plankton feeders suggested a possible way in which crabs imprisoned in these animals might obtain their food. It will be remembered that in those animals which feed on plankton—floating organisms—by using the gill as a food-sieve, the food-material is collected generally into cylindrical masses by means of mucus, and such is the case in mussels, cockles, oysters, and other bivalves. Thus animals living in the unoccupied space between the valves of these bivalves have ready access to a concentrated supply of food. Now it is easy to watch a pea-crab inside a mussel by cutting a window in the shell of the bivalve and allowing a crab to creep inside it. This has been done, and the bivalve fed on concentrated plankton. It was found that a hungry crab soon begins to feed in the manner described below.

The larger pea-crabs generally sit on the middle of the bivalve, with a pair of the bivalve's gills on each side. The smaller crabs may be found in any position inside a mussel, but are generally somewhere on the gill. When a crab is observed through a window in a mussel-shell it is seen that such a position is taken up generally so as to bring the edge of a gill-leaflet up against the abdomen of the crab. Now as the edge of a gill-leaflet is one of the main food-paths in a bivalve, it will be seen that when the mussel is feeding cylindrical masses of food will automatically pass along the edge of the gill-leaflets, and therefore along the part of the gill to which the crab has approximated its abdomen and within easy reach of its claws. When feeding the crab moves, or rather scrapes, its claws over the gill, and by means of the hairy nature of its claws easily catches hold of the mucus-strings entangling the food and transfers them to the region of its mouth. The claw is now scraped over the region of the mouth, and the specially hairy mouth-parts of the crab, working in an opposite direction, comb off the strings of food and press them into the mouth. The claw of this crab is apparently specially modified to enable it to be flexed about the middle of its length for giving the unusual scope of action required for the scraping movements.

It is thus seen that the pea-crab is a parasite, and no advantage of its presence to the host has yet been detected, unless it be the occasional association of the palps with the crab, for in this case the crab would be relieving the host of the necessity for transporting and expelling undesirable food; on the other hand, the crab would appear to do no more harm to the mussel than to make it collect food faster or for a longer time than would be necessary in an abundant supply of food if the crab were not there.

There is thus good reason to believe that those allies of the pea-crab which are known to live in plankton-feeding animals—for example, other bivalves and Ascidians—will be found to feed in the same way as this crab.

In the search for these pea-crabs during the summer it was observed that berried females were frequently found alone in a mussel, and that males appeared to be scarce; the method of fertilisation, therefore, was not understood, and appeared to be worth investigating. It is well known that in this crab there is a marked sexual dimorphism, the males being small, very hairy, and, it may be added, very active, while the females are large, relatively smooth, and extremely passive. Moreover, tiny females have apparently never been described. There was thus the additional problem of interest of the whereabouts of the tiny females—if, indeed, tiny females should exist. The whole of the phenomena suggested protandry—a suggestion that was strengthened by my obtaining a tiny female form moulted from a minute supposed male crab with a carapace only 2·7 mm. wide. This tiny female form—now 3·3 mm. in diameter—however, was found to have enormous spermothecæ crammed full of mature spiked sperm and only a trace of gonad, which was, however, obviously female. The moult of this specimen was now carefully examined, and found to possess the full number of abdominal appendages characteristic of the female, although otherwise not recognisable externally from a male.

Many other male-like tiny female specimens have been obtained, and also a series of moults which leave no doubt that the young male-like female attains the adult characters through a succession of moults. It is an interesting fact that all the larger females examined have been found to have their spermothecæ always full of mature sperm. It would therefore appear that this pea-crab copulates precociously at an extremely early age before settling down to its later sedentary life, and, so far as my observations have gone, it would seem that no further meeting with a male is necessary, although males have been found in the autumn inside the same host as large females; a newly moulted female, however, appears to have no charm for a male. Sexual dimorphism in the species is thus seen to be accompanied by dimorphism of the females, and the change from the male-like form of the female to the adolescent young-bearing female form appears undoubtedly to depend upon, and to occur after, copulation. It would also appear that copulation normally takes place inside the host, and that the males visit mussels in their search for females, since unwary male crabs have been found with their legs or bodies trapped by the mussel closing its shell before the crab could get inside. These crabs survive the rough treatment by reason of their extraordinarily strong carapace, and creep inside the mussel later when it must perforce relax and open its shell in order to breathe. The male-like female has a similarly hard carapace which prevents the animal being crushed to death if unluckily trapped by the mussel destined to become a host. Individual crabs have been found to be lacking a leg which might very well have been lost in this dangerous operation.

The life-story of this animal is probably not yet complete, since the tiny male-like female appears to possess a different sexual apparatus from the older forms, and a single male form has been found with a carapace closely resembling that of a female. It is hoped, therefore, to complete the investigations in the near future. J. H. ORTON.

The Laboratory, Citadel Hill, Plymouth,
November 10.

The Energy of Cyclones.

MY objection to Mr. Deeley's suggestion (NATURE, December 16, p. 502) that cyclones are caused by an access of warmth in the stratosphere is that in that case the troposphere ought to bulge upwards over the cyclone, whereas, in fact, it bulges downwards. The inversion at the boundary renders it certain that the interchange of air between the troposphere and the stratosphere is very slow, and for the few days of the life of a cyclone we may, to get a clear idea, imagine a light but impermeable film to exist at the boundary. If a patch of air above the film were warmed by any means it would expand outwards and reduce the weight on the film, which should, in consequence, rise. If, on the other hand, the film were drawn downwards, the temperature of the air above it would rise, because each air-particle as it lost in height would come under an increased pressure, and be warmed adiabatically. If, then, the air is drawn outwards horizontally from a cyclone in the upper part of the troposphere, the conditions as to temperature and the position of the top of the troposphere that are known to prevail are readily explained.

The point mentioned by Sir Oliver Lodge in his letter in NATURE of November 25 has been, I think, put forward by von Besold and others, but Sir Oliver seems to have overlooked the result of the heat set free by the condensation of the vapour. Could a cubic metre of damp air be confined in an adiabatic but extensible balloon and the vapour be condensed by any means, the result would be an increase of volume, for the expansion due to the heat produced by the condensation would far more than balance the contraction due to loss of pressure. If, indeed, the heat-energy due to the latent heat of vapour all took the form of kinetic energy in the atmosphere, quite a trifling rainfall would suffice to produce over the same area the most violent cyclone ever recorded.

W. H. DINES.

Benson, Wallingford, Berks.

The Mechanics of Solidity.

IN NATURE of November 18 last Mr. J. Innes pointed out that if a number of substances be arranged in order of increasing coefficient of linear expansion, then they are very nearly in a series of decreasing hardness, as shown by Brinell's, Moh's, or Auerbach's test, and he has, therefore, suggested, that it should be possible to obtain a fair idea of the so-called mechanical properties of substances from an inspection of their more fundamental physical constants.

It seems highly probable that there is some simple relation between the many physical constants of substances, and, indeed, many formulæ connecting them have been put forward, viz.:

(1) Sutherland (*Phil. Mag.*, 1890 and 1891) proposed to find the characteristic frequency of the atoms of elements by the formula

$$\nu \propto \frac{\sqrt{\frac{T_s}{A}}}{aT_s V^{\frac{1}{3}}},$$

where ν is the characteristic frequency of the atoms, T_s the melting point on the Absolute scale, A atomic weight, a mean coefficient of linear expansion between 0° Abs. and T_s° Abs., and V atomic volume $=A/\rho$, where ρ is the density.

(2) Einstein (*Ann. d. Physik*, 1911) has proposed

$$\nu = k\sqrt{\frac{V^{\frac{1}{3}}}{K.A}},$$

where ν, V, and A have the same significance as above, K is the bulk modulus of elasticity of the body, and k a constant which Einstein's theory demands should have the value $2\cdot8\times10^7$, but for which the empirical value $3\cdot3\times10^7$ seems to agree much better with observation.

(3) Debye (*Phys. Zeits.*, vol. xviii., p. 276, 1917, and *Ann. d. Physik*, vol. xiv., p. 789, 1912) asserted that ν is the frequency of vibration of those elements in a substance which determine the velocity of sound in it, and he has therefore calculated ν from E, and σ, where E is the Young's modulus of elasticity of the body and σ its Poisson's ratio.

If, now, the ν of Debye and that of Sutherland or Einstein are identical in their physical significance, we may write

$$\frac{\sqrt{\frac{T_s}{A}}}{aT_s V^{\frac{1}{3}}} \propto \nu \propto \sqrt{\frac{V^{\frac{1}{3}}}{K.A}} \propto F(E.\sigma),$$

where $F(E.\sigma)$ is Debye's function for the determination of ν in terms E and σ.

It is of interest to note that Debye's formula does not involve an empirical constant, and that the constant of proportionality in Sutherland's formula is $\sqrt{P}$, where P is Dulong and Petit's constant, *i.e.* the product of the specific heat and atomic weight of the element.

Other formulæ have been put forward by Planck, Lindemann, and Grüneisen, but it is not considered necessary to add them here.

For a discussion of the agreement of these formulæ with experimental results the reader is referred to *Phil. Mag.* for December, 1917, "Atomic Frequency and Atomic Number, Frequency Formulæ and Empirical Constants," by Dr. H. S. Allen.

Perhaps these formulæ are of the type of which Mr. Innes is in quest.

It will be observed that, in the foregoing, reference to the "hardness" value has been omitted; it is now proposed to justify this omission.

The moduli of elasticity, the ultimate strength, and the coefficients of expansion of a substance are, without doubt, the mathematical expression of certain body or bulk properties, and their magnitudes will depend on the state of equilibrium of the molecules within and throughout the body, as well as on those on the surface. On the other hand, the hardness of a substance was defined in *Engineering* for December 12, 1919, as "the resistance of a surface to deformation by mechanical means," and is, therefore, a surface effect and not a bulk effect. If this is admitted, then the hardness number of a surface is probably closely related to its surface energy, and is, perhaps, a measure of a property analogous to the surface-tension property of a liquid. In this connection proposals put forward by Frenkel (*Phil. Mag.*, April, 1917) on "The Surface Electric Double Layer of Solid and Liquid Bodies" are of interest. In that paper it is maintained that every free surface is a parallel plate condenser the outer plate of which is negatively charged, and consists of electrons in the outer half of their orbits about their positive nuclei which form the positive plate. The charge per unit-area of this condenser is calculated from (1) the number of positive nuclei per unit of area of surface, (2) the number of electrons moving in orbits about one nucleus, and (3) the electronic charge.

The distance between the plates is obtained from the mean radius of orbit of the electrons of any one atom. Thus the energy per unit-area of surface can be calculated. Results obtained in this way were shown to be in agreement with the known surface energy and contact potential of the various elements considered.

It seems to the present writer that attempts to obtain formulæ connecting the mechanical constants of elements with their fundamental physical constants must be along this line if the hardness number is the main object of the search. Many difficulties, however, remain to be overcome, for it appears that the plasticity of a substance must have a much greater effect in determining the "Brinell hardness" than it does in determining the "Moh hardness" of any given substance.

V. T. SAUNDERS.

Royal Naval College, Dartmouth,
South Devon, November 29.

Needs of Polish Universities.

I AM travelling in East Galicia, and have only just seen Mr. H. G. Wells's remarks on the needs of scientific workers in Russia (see NATURE of November 11, p. 352). Using Mr. Wells as a text and applying it to Russia's neighbour, I should like to enter a plea for the Polish Universities of Krakow, Lwów (Lemberg), and Warsaw, which stand in the greatest possible need of American, English, and French scientific and technical literature. From the middle of 1914 to 1918 such literature was unobtainable, and since 1918 the rate of exchange—to-day 1500 Polish marks to 1*l.*—has placed it beyond the possibility of purchase by the three impoverished universities. For some months the Friends' Relief Mission has been making an effort at home to arouse practical interest in the problem, and recently we received some volumes of NATURE. These I took to the librarian of Warsaw University, who showed me over the library. The new English books could have been counted on the fingers of the two hands, and in the periodical-room not a single English periodical was being received, and only two in French. Similar conditions obtain in Krakow and Lwów, capitals of West and East Galicia, and two of the most important intellectual centres in reunited Poland.

CUTHBERT E. A. CLAYTON,
Sec. in the Field of the French Poland Unit.
Nadworna, East Galicia, November 24.

WE believe that the Anglo-American University Library for Central Europe exists to supply the need to which Mr. Clayton refers. The address of the secretary is London School of Economics (University of London), Clare Market, W.C.2.—ED. NATURE.

Domestic Fires and Fuels.

THE Air Pollution Board—a sub-committee appointed by the Manchester Corporation in 1915 to study the smoke nuisance—initiated an investigation of the domestic coal fire by Mrs. M. W. Fishenden. In 1917–18 the Department of Scientific and Industrial Research made grants in aid of the work, and now the Fuel Research Board has, with the concurrence of the Manchester Board, published the results,[1] expressing the opinion that "the investigation into the efficiency of the open fire has yielded a collection of carefully ascertained data, from which it is believed that a new departure can be made in dealing with the whole question of the use of smokeless solid fuel in domestic fires."

It is even yet not sufficiently recognised how grave an offender is the domestic coal fire in the production of the smoke nuisance in regard not only to the quantity, but also to the quality of smoke, although this was shown by Prof. J. B. Cohen many years ago. The Manchester Board was doubtless right in basing the work, as the chairman, Mr. E. D. Simon, points out in his introductory summary, on a scientific study of the domestic grate, about which an astonishing lack of precise information was found. If fires could be rendered more efficient, it was argued that a reduction in coal consumption and in the corresponding smoke production would automatically follow. It was hoped at first to draw up a standard of efficiency in fireplaces which might be enforced by local by-laws. This hope, however, proved illusory, as will be shown later. Determinations were first made of the "radiant efficiency" as the most important property of coal fires of different types—*i.e.* the proportion of the heat of combustion of the fuel which was radiated into the room. Here Mrs. Fishenden was able to start with the methods already elaborated for the study of gas fires by a joint committee of the Institution of Gas Engineers and the University of Leeds. It was found possible to adapt the so-called "Leeds test" to the more difficult problem of the solid fuel fire. The figures given are for the total radiation of heat from lighting to dying out, although from the point of view of the users of a fire the heat evolved in the early period and at the end is of little value. This emphasises the fact that solid fuel fires are less satisfactory for intermittent use or for short periods.

The results obtained were unexpected. The grates examined did not differ much in radiant efficiency. Fed with ordinary bituminous house coal from the Yorkshire Haighmoor (not "Haighmore") seam, all gave figures between 20 and 24 per cent. The superior radiant efficiency of the grates of modern construction proved to be a myth. How is this to be reconciled with the common experience that the newer fires appear to give more warmth in the room for less coal? It seems to be due to the constriction of the opening into the flue, which prevents the flow of an excessive quantity of heat-conveying air into the chimney. Strong draughts are avoided, and comfortable conditions in the room can, therefore, be maintained by a smaller consumption of fuel. Moreover, massive iron bars and cheeks with their cooling action are avoided; fireclay is substituted so as to promote the maintenance of a small fire, while the fuel burns more slowly and more completely. The draught below the fire can be restricted, and that in itself puts a great check on the fire.

The advantages are thus real, but not in the direction which is popularly supposed. It was shown that the mere removal of the bars from a grate has only a negligible effect on the radiant efficiency of a fire. Of course, the ventilating effect of the fire is reduced if the opening to the flue is lessened, but this seems generally to be an advantage. Here one looks expectantly, but vainly, for measurements of the ventilating effect of the newer types of grates. Mrs. Fishenden's measurements were made on an old-fashioned grate provided with an adjustable flue damper. With unrestricted draught it was found to move up the chimney as much as 25,000 cub. ft. per hour, although by regulation of the damper this was reduced to one-tenth. Such measurements on the new types of fire would have been specially valuable for the comparison of different systems of domestic heating. In domestic architecture in this country heating and ventilation go together. There seems to be no practical alternative to the chimney flue, simple, cheap in upkeep, and automatic in action, for the ventilation of smaller houses. The recognition of this led to careful measurement of the ventilating action of gas fires by the joint committee of the Institution of Gas Engineers and the University of Leeds, and similar measurements for modern coal grates would be very valuable.

The experiments on different fuels burnt in the same grate are specially interesting. When burning coal, the radiant efficiency was found to be 24 per cent. With anthracite the figure was 27 per cent. With dry gas coke 28·5 per cent. of the heat was radiated, but this advantage over coal was lost if more than 10 per cent. of moisture was present. Two dry cokes produced by low-temperature carbonisation radiated respectively 31 and 34 per cent. of their heat, but here again the presence of moisture was found to have a deleterious effect. Briquettes of coal proved relatively inefficient with only 19 per cent. radiation. The figures point a moral to producers of coke—*i.e.* the desirability of preventing the degradation of an excellent fuel by excessive moisture, although there are technical difficulties in eliminating moisture altogether. The results for low-temperature coke are striking, and "confirm the fact accepted by all smoke-abatement reformers that it is exceedingly desirable that a fuel of this nature

[1] "The Coal Fire. A Research by Mrs. M. W. Fishenden for the Manchester Corporation Air Pollution Board." Fuel Research Board. Special Report No. 3. Pp. 112. (H.M. Stationery Office.) Price 4*s.* net.

should be put on the market at a reasonable price." The friability of such cokes has proved a grave obstacle, and, if one seeks to avoid it by briquetting, Mrs. Fishenden's results suggest that any superiority in radiating power would be more than wiped out, while the high cost of pitch—the natural binding material—is not helpful. The Fuel Research Board and private workers are busy with the problem.

One cannot help thinking that the real domestic smoke problem is presented, not by the grates of the type studied by Mrs. Fishenden, but by the enormously more numerous and more voracious kitchen ranges used for cooking as well as for heating. Would a smokeless fuel prove serviceable for these? The present report does not deal with the kitchen range.

Mrs. Fishenden has exploded several popular fallacies. Powders have been sold (under promising names) which are alleged to effect marvellous economies in fuel, as vouched for by people whose official descriptions ought to have implied better things. Some of these powders were examined and found to be essentially common salt coloured with iron oxide. No appreciable effect on the radiant efficiency of a fire consuming coal treated with these salts could be detected. To-day, when coal and money are so scarce, a protective publicity might well be given to these tests in the daily Press.

It appears generally from Mrs. Fishenden's work that the wastefulness of the open fire may be lessened by the use of carbonised fuel, and particularly by the cutting down of draught so as to limit the air drawn through the room and into the chimney to the quantity required for ventilation. The use of solid fuel is still cheaper than that of gaseous fuel for fires which have to be in constant use.

Not the least useful part of the report is the appendix, containing a summary of recent bibliography of work on domestic heating appliances. Attention may well be directed to earlier students of the problem—Rumford, Peclet (whose "Traité de Chaleur" still repays perusal), and more recently Dr. Pridgin Teale, of Leeds, who may be regarded as the pioneer of modern grate reform in this country. Peclet, and perhaps Rumford, seemed quite clear about the significance of excessive flue draught and the need for restricted and variable flue openings, and in reading his treatise one can only marvel that the manufacture of crude appliances has continued to the present day. Still, Mrs. Fishenden's work has placed the whole subject on a more substantial foundation of carefully ascertained data, an achievement which should prove valuable in the campaign of smoke abatement and fuel economy, and at a cost which seems to be relatively insignificant. J. W. C.

A Handbook to Roman Pottery.[1]

THE term "terra sigillata," denoting certain well-known classes of Roman pottery, may be unfamiliar to the ordinary reader, but it is gradually coming into use in place of the somewhat misleading "Samian ware" of the nineteenth-century antiquarian. The late Prof. Haverfield, indeed, stoutly upheld the use of the older term; but it is open to decided objections, being purely conventional, unhistorical, and non-descriptive. Such expressions as "Roman red-glazed ware," "Gaulish red ware," etc., may be more accurate, but are not sufficiently definitive. The authors of the work under review have, therefore, followed Continental precedent and adopted this term, which strictly denotes "clay decorated with stamped patterns" (from *sigillum*, a stamp). The ware with which they deal is the pottery produced under the Roman Empire and found in all parts of Western Europe, which is marked by the use of a fine red paste and a lustrous red glaze, and usually ornamented by means of patterns and figures in relief.

It is the first attempt made in this country to produce a handbook to the study of this pottery, which during the last twenty years has made a great advance, owing to the labours of British, French, and German archæologists, and to the more careful attention paid to the results of scientific excavations in this country. We most heartily congratulate the authors on their work, which is distinguished both by exhaustive knowledge and by scientific accuracy.

Their aim has been to arrive at definite conclusions concerning the development of Roman pottery under the Empire by a diligent study of such details of technique, form, decoration, and design as can be of assistance for purposes of dating, and to base on the results of detailed study

FIG. 1.—Vase of La Graufesenque ware (Form 29) with scroll decoration (about A.D. 40).

a general consideration of the evolution of this pottery and the sources of its inspiration.

The book is divided into ten chapters, the first two being of a general and introductory nature. Chap. iii. deals with "dated sites"—*i.e.* those where the approximate dates of occupation are known, such as Haltern in Germany (11 B.C. to A.D. 9). Chap. iv. gives a list of the potters whose names are stamped on the vessels, arranged in chronological groups. In chap. v. the vessels decorated in moulded relief are discussed under

[1] "An Introduction to the Study of Terra Sigillata: Treated from a Chronological Standpoint." By Felix Oswald and T. Davies Pryce. Pp. xii+286+lxxxv plates. (London: Longmans, Green, and Co., 1920.) Price 42s. net.

the principal forms of bowls employed. The evolution of the forms and decoration is worked out in a most lucid and interesting manner. The chronological value of this development is further described in chap. vii., and in chap. vi. we have an interesting discussion of the origin of the decorative designs. The figure-subjects are mostly to be traced to the art of the Augustan period, and the decorative motives in many cases to earlier phases of Greek art. It seems a little doubtful,

FIG. 2.—Vase of La Graufesenque ware (Form 30) combining scrolls with figure subjects (about A.D. 60).

however, whether motives and methods of decoration which were employed in early Greek art, and disappeared in the sixth century B.C., or even earlier, can have actually influenced the Roman potter. An instance is the "nautilus" ornament found on the Arretine vases and some early Gaulish wares of the first century after Christ. The nautilus certainly occurs in Minoan pottery, but its use was localised, and it is not known in Greek art. It is possible that this pattern is really intended to represent a fern-frond.

Chap. viii. is devoted to a discussion of the plain wares which have only potters' stamps without decoration, and chap. ix. to other methods of decorating *sigillata* ware by painting, incising, or *en barbotine* (patterns produced in relief by thick layers of liquid clay). The final chapter deals with the origin and evolution of *terra sigillata*, and is a general summing up of the whole subject.

There are no fewer than eighty-five excellent plates, all drawn by hand, with adequate biblio-

FIG. 3.—Vase of Lezoux ware (Form 37) with panel decoration (about A.D. 100).

graphical references, and a useful map of sites forming the frontispiece. The general and detailed bibliographies on pp. 245 ff. will also be invaluable to the student of the subject. We should have been glad to discuss this admirable work in much fuller detail, but space forbids, and we can only recommend those who have any interest in the subject to lose no time in becoming acquainted with its contents.

Our illustrations reproduce three typical forms of Gaulish vases with decoration.

Industrial Research Associations.

VII.—THE RESEARCH ASSOCIATION OF BRITISH MOTOR AND ALLIED MANUFACTURERS.

By H. S. ROWELL.

NO branch of engineering is so much the creature of taste and fashion as the automobile industry. No industry of anything like the same dimensions is so much dependent on the views, almost the caprices, of the layman. Almost certainly no industry in this country has had such a meteoric or rather rocket-like post-war career as that responsible for the manufacture of motor vehicles. These facts must be borne in mind in considering the development of the Research Association of British Motor and Allied Manufacturers.

After the armistice the release of petrol supplies, the diversion of manufacturing agencies from war work, and the natural desire of an overworked public for convenient locomotion and healthy relaxation gave the motor-car trade an unprecedented boom. Motor-car manufacturers were not only confronted with all the distracting problems of reconstruction, but, in addition, they had prospects of—several firms, indeed, had orders for—some years of work. While one or two other research associations were formed as a vital necessity to preserve the existence of the corresponding industries against foreign competition, the motor trade had at the time of the incorporation of this association in May, 1919, no such incentive. At that time to many in the motor industry it must have seemed a luxury, if not an extravagance. Those who have had to do with the inauguration of new societies, especially of societies novel in form or object, know how much work and time are involved in seeking, and often in reconciling or converting, the views of busy men. Even then much preliminary work is necessary before staff can be appointed for the necessary executive work. The Research Association of British Motor and Allied Manufacturers was formed under the ægis of the Association of British Motor Manufacturers, and it is largely to the energy and enthusiasm of

Mr. H. C. B. Underdown, president of the latter body, that the daughter association owes its existence.

The active work of the Research Association of British Motor and Allied Manufacturers began on June 1, 1920, with the appointment of the present writer as technical secretary. Since that time considerable progress has been made in organising committees and arriving at a policy by which to guide future work. A bureau of information has also been established from which are issued classified abstracts of most of the important papers dealing with matters relevant to the automobile. There is in many quarters a rooted and well-founded objection to the collection of information in this way; it is often asked: "Where will it end?" The answer to this question is neither easy nor necessary, but the fact remains that already the information bureau has been of great value. The needs of various industries are different, and the organisation of the research association must fit in with its own particular industry. In the case of one textile industry there was little or no scientific foundation on which to build, and thus the first task of its research association was to gather information. In the motor industry, on the other hand, there is a wealth of information, but it is widely spread and often hard to come at; as one example out of many we have the transmission of heat across a plate between two moving fluids. This problem has been investigated by many engineers in many countries, generally with reference to the steam boiler; the same principles must govern the radiator and heated induction pipe of the motor-car. The abstracts sent out to the members of the association not only keep their technical and design staffs in touch with new developments at home and abroad, but as they are carefully classified they will in course of time provide a basis on which research work may be founded. Moreover, they will become a work of handy reference.

Time teaches, and the views here presented are naturally subject to modification by experience. At present the tasks in front of the association may be set out as follows:—

(1) Collecting, recording, and disseminating to members accurate technical information.

(2) Consultative and advisory work for members of the association.

(3) Original research and investigation into matters of importance to the industry of which knowledge is at present unsatisfactory.

(4) Co-operation with allied industrial and scientific workers.

(5) Examination of new inventions, and, in promising cases, their experimental development.

(6) Impartial tests and verdicts.

A few words of explanation on these brief headings are fitting.

The bureau of information has already been discussed.

Regarding consultative work, it must be clear that a highly trained scientific staff is able to help works engineers and designers in many ways. There are, in any case, two main advantages to be derived from consultative work in a research association quite apart from the immediate solution of any difficulty; not only are the obstacles encountered by one firm brought to the notice of other firms in the association, thus showing them what to avoid, but also the scientific staff is kept in touch with the men in the works, thus learning their needs, their outlook and point of view, and possibly some of the manifold experience which is rarely formulated.

Co-operation with allied trades is especially necessary in motor-car research, for no other product, except perhaps that of the shipbuilder, involves so many handicrafts and sciences as the automobile. As examples, we have spring-making; lamp manufacturing; electrical apparatus for starting, lighting, and ignition; rubber tyres; upholstery; body building; and all the general work implied by mechanical engineering. It would clearly be unjust that the Research Association of British Motor and Allied Manufacturers, an association at present of chassis builders, should, even if it had the necessary resources, embark on such a wide sea of troubles. Thus the title and aims of the association have co-operation in view, and it is pleasant to know that there are now prospects of firms in the allied trades joining the association very shortly. With those allied industries that have already formed research associations close collaboration will be encouraged.

The examination of new inventions may seem to many a piece of unwisdom, since it may be concerned more often with design than with research. On the other hand, it must be admitted that an unbiassed and scientific view is necessary to do justice to the inventor; nor may we forget the epoch-marking innovations which we owe to non-technical people; the textile industry, for example, owes much to a barber and to a clergyman.

The views of men are the product of their experiences, and in the hurry and bustle of practical life notions and prejudices are acquired which time and leisure for reflection would dispel. Or, on the other hand, the natural bias of paternity may lead the designer to retain his devices when better substitutes are available. In such cases a research association can serve a useful purpose in giving an impartial, or at least a different, view. Later, as the organisation develops, it may be that the field of judgment will be extended in order to expose or confirm the various claims of blatant advertisers. In this way the true interests of the public and of the automobile industry will be served.

The objects set out above are probably not the same as those of other research associations, but the needs of various industries are different; it was sound statesmanship that led the Department of Scientific and Industrial Research to give each industry its freedom in the research movement. In considering the list of objects given above, it must not be assumed that the order adopted is that of relative importance. The great difficulty in securing suitable premises, and the congested and overworked state of university institutions, have temporarily displaced original research from its deserved place of priority. The collecting of information, on the other hand, was at once useful and feasible.

Much emphasis has been given, both in this country and in the U.S.A., to the view that industrial research associations should seek after fundamentals. Quite recently in an important publication appeared the sentence: "It cannot be stated too strongly that the main object of research associations is fundamental research, and that consequently results will usually be slow in coming." With a full sense of the profound respect due to the authors of this statement, the present writer begs leave to disagree. In his view, the main object of industrial research associations is profit, for without profit no industry can live. Disregard by men of science of this vital fact is probably responsible for much of the apathy shown towards science by men in commerce and industry. Here it must be added that the profit point of view is not necessarily a short view; let the vista be as long and as broad as economic conditions warrant, and in cases of doubt let the error lie in distance and in breadth.

The membership of the Research Association of British Motor and Allied Manufacturers represents at present only about one-third of the British motor industry, but it is the object of the council of the association to build up an organisation which shall become a representative national body in the automobile world, and, by working on a practical yet progressive policy, fully adapted to the present temper of the trade, it is hoped to convince not only the entire British motor industry, but also the various allied and accessory trades, of their interest in research. It is clear that the larger the membership becomes, so much the greater are the resources of the association and the benefits of membership. Until the entire British motor industry is included, strict secrecy will be observed in regard to any results of advantage to the trade. At the same time, the interests of research workers (in the pay of the association), to whom credit is an important form of reward, will be assured by publication of their results after members of the association have had, say, three or five years' start of non-members.

There is one difference between pure science and technical science which it is believed has not been emphasised before. When a technical worker is given a problem by industry, the answer or solution is, as a rule, wanted at once, whereas a worker in pure science has, or should have, unlimited time at his disposal. This cardinal difference imposes a totally different solution in the two kinds of work. The technologist may be called upon to eliminate a wasteful process or a dangerous condition. He is not authorised to spend twenty years in finding out a perfect process or in determining exactly what condition is just safe. He is asked to cut out as much waste as possible at once, and, if advisable, to go on improving the process, or in the other case his task is to find out what is safe enough with a reasonable margin for the various probable errors to be expected. The great majority of technical problems cannot be enunciated precisely; only a more simple analogue can, as a rule, be considered. The end in view is an immediate solution sufficiently accurate for the work in hand.

When the technical worker has solved his problem and passed the solution to the designer, he will see, as a rule, unless his scientific curiosity be dwarfed and shrunken, many interesting paths which invite his investigation had he but the needful time and equipment. It is here that he can serve pure science by handing on his boundary problems to the specially gifted men who devote their lives to the development of science as distinct from its applications. How much is handed on in this way and how much retained for investigation by the research association will depend on the ability, vision, and other resources of those concerned; the experience of industrial research organisations in Germany and in America seems to show that the short view does not pay in the long run.

Obituary.

Sir D. E. Hutchins.

The death in New Zealand was announced in the *Morning Post* of December 3 of Sir David Hutchins, the well-known forester, at seventy years of age. Sir David (with eleven contemporaries, including the late Prof. W. R. Fisher, Mr. E. C. Hill, late Inspector-General of Forests in India, and Mr. E. P. Popert, late Forestry Adviser to the Commissioners of Woods and Forests) was appointed a probationer for the Indian forest service in the spring of 1870, and sent to France for instruction in forestry. Shortly afterwards, on the outbreak of the Franco-German War, he returned and studied, with the other probationers, botany and other auxiliary subjects in Scotland under the supervision of the late Dr. Cleghorn, himself a retired distinguished Indian forest officer. After the end of the war in 1871 Sir David returned to France and studied forestry at Nancy until the autumn of 1872. He joined the Indian forest service at the end of that year, and remained in it until the end of 1885. Owing to ill-health, he was then transferred to the forest service of Cape Colony. During the latter part of his service in India Sir David was occupied with the measurement of Casuarina plantations which had been established along the Madras coast. From the statistics thus obtained, he calculated the "form factors" for the species, this being the first attempt of the kind made in India.

Sir David remained in South Africa about twenty years as Conservator of Forests, Cape Colony. During that time he introduced a variety of exotic species, principally conifers and Eucalypts, to supply the colony with the timber which the indigenous forests could not yield. He also caused similar plantations to be established in the Transvaal and the Orange Free State. These planting operations were on a large scale, so that their area amounts now to 75,000 acres; they have been very successful, especially from a financial point of view. Later, Sir David was transferred to British East Africa as director of forest operations, and in that capacity he published a voluminous report on the forests of that Protectorate. He also visited Cyprus and reported on its forests. He paid visits to the Canaries and other tropical and semi-tropical countries, making a special study of the forest vegetation of the last-mentioned. The knowledge thus acquired enabled him to recommend suitable species for introduction to other countries possessed of a similar climate.

In the year 1914 Sir David proceeded with the British Association to Australia, where he remained for two years studying the forest conditions of that country. At the end of that time the Government of Western Australia published for him, in 1916, a full report on Australian forestry and his suggestions as regards future action to be taken by the Governments of these colonies. The report attracted great attention, and Sir Ronald Munro-Ferguson, at that time Governor-General of Australia, expressed the opinion that "nobody has ever written on Australian forestry as Sir David Hutchins has done."

From Australia Sir David proceeded to New Zealand, where he examined the forests, paying special attention to the "Kauri" pine (*Agathis australis*). He urged that the small remnants of that queen of pines should be protected and enlarged. It appears that he died while passing a report on the New Zealand forests through the press. Sir David Hutchins was an enthusiastic forester, who had amassed a vast amount of knowledge on forestry subjects, and especially on semi-tropical forest vegetation. In spite of his enthusiasm carrying him sometimes too far, he did most substantial service to the Empire, and his friends were pleased to see his merits appreciated by the bestowal of a knighthood some months before his unexpected death.

SIR CHARLES BRUCE, G.C.M.G.

BY the death, at the age of eighty-four, of Sir Charles Bruce the country has lost a great scholar and an efficient administrator. The son of an Indian Civil Servant, in his early years Sir Charles devoted himself, mainly in Germany, to philological study, chiefly in Sanskrit and Zend-Pahlavi, and he did valuable work in connection with the great Sanskrit dictionary published by the Academy of St. Petersburg. He was next appointed rector of the Royal College at St. Louis, Mauritius, whence he was transferred as Director of Public Instruction to Ceylon. He returned to Mauritius as Colonial Secretary, and was later appointed Lieutenant-Governor of British Guiana. In recognition of his services he received the knighthood of the Order of St. Michael and St. George. In 1897 Sir Charles returned to Mauritius as Governor, where, with the hearty support of Mr. Joseph Chamberlain, then Colonial Secretary, he carried out important reforms in the public services, and as an administrator gained much popularity among the people of the island, until his retirement from the public service in 1903. During his colonial service of more than thirty-five years he gave much attention to ameliorating the condition of the Indian immigrants to our Crown Colonies, a task to which he devoted himself after his retirement. In 1910 he published an important work, "The Broad Stone of Empire," dealing with the problems of Crown Colony administration in the light of his wide and varied experience. Sir Charles Bruce will be regretted by many friends as a man of devout spirit and of singular independence and honesty of purpose, with much charm of manner and kindliness of heart.

Notes.

HIS HIGHNESS THE PRINCE OF MONACO has issued invitations to representative scientific workers of all countries to be present at the formal opening of the Institut de Paléontologie Humaine at 1 rue René Panhard, Paris, to-day, December 23. The President of the French Republic (M. Millerand) has promised to attend. The institute owes its origin to the munificent benefactions of the Prince, whose interest in archæological problems made possible the systematic exploration of the Mentone caves. Its work is most widely known to archæologists through the magnificent series of publications covering the exploration of Palæolithic caves, notably those of Grimaldi, Altamira, and La Pileta. Of the excavations described in these publications some have been undertaken under the auspices and at the expense of the institute. This is especially the case with those of more recent years, such as the exploration of the cave of La Pileta (Malaga), undertaken by MM. Breuil, Obermaier, and Verner. Although it did not undertake the actual exploration of the Altamira cave at Santander, carried out by Dr. Cartailhac and the Abbé Breuil, it was responsible for the publication of the results. It was through the institute and the generous assistance given by the Prince that it was possible for the authors to describe the site and its culture on a scale and with a wealth of illustration which have made the remarkable series of examples of prehistoric art familiar to archæologists who are not fortunate enough to be able to visit the cave in person.

MUCH interest has been aroused by the registration on December 16 of one of the greatest earthquakes of recent years, and the interest has been increased by the mystery which at present attends the position of its origin. The first preliminary tremors reached West Bromwich at 12h. 17m. 14s. p.m.; the second tremors arrived nine minutes later, indicating an epicentral distance of about 68° of arc. The oscillations at this station were so violent that Mr. J. J. Shaw's seismograph was thrown out of action. The epicentral distance from Oxford was estimated at 67°. From the American records it would seem that the distance from Washington was about 43°. Various positions have been suggested for the origin—China, beneath the Pacific Ocean to the north of Japan, the Atlantic between Sierra Leone and Brazil, or the South Pacific. Prof. H. H. Turner, writing in the *Times* of December 21, suggested that the place of origin was in the Gulf of Mexico, but since then he has seen evidence which indicates an Alaskan origin for the earthquake. No seismic sea-waves have been reported from any place, and this absence seems to favour an origin that is, at least in part, terrestrial. On the other hand, an earthquake so violent must have been felt to a distance of some hundreds of miles from its origin; and thus, if the origin were terrestrial, it must either be in a country from which outgoing messages have been censored or one with few observers or inadequate means of communication—such, for instance, as Yakutat Bay, in Alaska, which is, however, only about 64° from the British stations.

THE announcement that the King has approved of the appointment of Prof. J. C. Irvine as Principal of the University of St. Andrews has been received with feelings of much satisfaction by men of science throughout the country. This is not the first occasion when the chief administrative office in the oldest University of Scotland has been filled by a man of scientific eminence, for Sir David Brewster occupied the Principalship of the United College from 1838 to 1859, and his successor was J. D. Forbes. After a period of years, during which the University was guided by those men of distinction in the world of letters, John Campbell Shairp, Sir James Donaldson, and Sir John Herkless, it now falls to the lot of a chemist to direct the policy of the University of the grey city by the northern sea. The new Principal was a pupil of Prof. G. G. Henderson in Glasgow Technical College before going to St. Andrews as an undergraduate. He afterwards spent a couple of years in Leipzig, where he came under the inspiration of Wislicenus, returning in 1901 to his *alma mater*. On the retirement of Prof. Purdie in 1909 the chair of chemistry in the United College was filled by his assistant. During the past twenty years Prof. Irvine has devoted himself to research on the chemistry of carbohydrates, in which branch he may now be regarded as the leading living authority. He has been particularly successful in imparting much of his enthusiasm to his students; many of the men associated with him in his publications in the Journal of the Chemical Society are graduates in arts who, with no scientific predilections, were attracted to the study of chemistry by the personality of the professor. Principal Irvine's scientific work was recognised by his election as F.R.S. in 1918, whilst his valuable war services earned for him his C.B.E. in the present year. His many friends in academic circles both in St. Andrews and in Dundee have full confidence that in his hands the best interests of their University are in safe keeping.

THE recent reports relative to a fall of rock involving the summit of Mont Blanc, however improbable they might appear to those who have knowledge of the ground, have naturally aroused general attention. The *Daily Mail* of November 27 published a communication from Geneva correcting the idea that the summit had suffered change, but recording the fall of the face of a rock-precipice on to the Brenva glacier, and the sweeping of an ice-avalanche from this glacier through the woods of "Portud" (La Pertu). The *Journal des Débats* for November 29 quotes information given by M. Vallot, director of the Mont Blanc Observatory, to the *Eclaireur de Nice*. M. Vallot points out that the summit is composed of an ice-mass of variable level, and that the source of the avalanche could not have been determined from the Italian side. Presumably this refers to dwellers in the Val di Veni. M. A. Lacroix, permanent secretary of the Paris Academy of Sciences, very kindly informs us that accurate details are not yet to hand, and that the matter may resolve itself into an avalanche of ice rather than a fall of rock.

A SMALL expedition is being organised in the University of Oxford to visit Spitsbergen next summer with the view of conducting researches in ornithology, botany, and palæontology. Work will be confined mainly to the west coast, but if ice conditions permit the northern and north-eastern shores of the mainland will be visited and an attempt made to cross New Friesland and to ascend some of the unscaled peaks in that part of the country. It is proposed to charter two or three sealing sloops in Norway to accommodate the expedition. The first sloop would arrive in Spitsbergen early in June, making for the bird rookeries on the north and west coasts of Prince Charles Foreland; the others would arrive later for work on the north coast. The explanatory side of the expedition's programme depends largely on weather conditions, but the other researches can certainly be carried out. The staff of the expedition has been selected, and will, we understand, include the Rev. F. C. R. Jourdain, who is chairman of the organising committee. Expert advice is being taken in the preparation of the plans and in the selection of the equipment. The *Times* understands that the cost of the expedition is estimated at about 3000*l.*, towards which several generous contributions have already been promised. The expedition has the official sanction and support of the University of Oxford.

THE Forestry Commission was established in order to secure an adequate supply of home-grown timber, and many people imagine that this can be effected by State afforestation alone. The 1,770,000 acres which the Government has decided to acquire and plant with trees during the next eighty years are quite inadequate. Much of the planting must therefore be done by private owners, who control about 3,000,000 acres of woodlands. Owing to the war and other causes, the great bulk of mature timber on these estates has disappeared, and in all probability only 750,000 acres are fully stocked with trees more than twenty years old. Certainly a great part of the conifer woods has been either clean-felled or thinned to such an extent as to be no longer productive. The remedy is the encouragement of replanting by private owners, who are now deterred by high wages, the enhanced cost of plants, etc. The Forestry Commissioners are prepared to assist private owners in two ways: either by entering with them into partnership in profit-sharing schemes or by giving grants in aid of planting and of establishing a crop under approved conditions. These grants are fixed at 2*l.* per acre for conifers and 4*l.* per acre for broad-leaved trees, and are repayable whenever an owner makes ultimately a profit exceeding 4 per cent. As the new planting season is in full swing, applications for grants should be addressed direct to the Assistant Commissioner concerned: For England and Wales—30 Belgrave Square, London, S.W.1; for Scotland—25 Drumsheugh Gardens, Edinburgh; and for Ireland—6 Hume Street, Dublin.

THE annual exhibition arranged by the Physical Society and the Optical Society is to be held on Wednesday and Thursday, January 5 and 6, at the Imperial College of Science, South Kensington, and will be open both in the afternoon (from 3 to 6 p.m.) and in the evening (from 7 to 10 p.m.). Sir W. H. Bragg will give a discourse on "Sounds in Nature" at 4 p.m. on January 5. Dr. Archibald Barr will lecture on "The Optophone: An Instrument which Enables the Totally Blind to Read Ordinary Print" at 8 p.m. on January 5 and at 4 p.m. on January 6. After the lecture a demonstration will be given by a totally blind person. At 8 p.m. on January 6 Prof. C. R. Darling will give a discourse on "Some Unusual Surface-Tension Phenomena." All the lectures will be illustrated by experiments. About fifty firms will be exhibiting, and a number of experimental demonstrations have been arranged. We understand that invitations have been given to the Institution of Electrical Engineers, the Institution of Mechanical Engineers, the Chemical Society, the Faraday Society, the Wireless Society of London, and the Röntgen Society. Admission in all cases will be by ticket only, and therefore members of the societies just mentioned desiring to attend the exhibition should apply to the secretary of the society to which they belong. Others interested should apply direct to Mr. F. E. Smith, hon. secretary of the Physical Society, National Physical Laboratory, Teddington, S.W.

THE Imperial Bureau of Mycology is the outcome of a proposal unanimously adopted by the Imperial War Conference in 1918 that a central organisation should be established for the encouragement and co-ordination of work throughout the Empire on the diseases of plants caused by fungi in relation to agriculture. The committee of management consists of some of the foremost biologists in the country, with Viscount Harcourt as their chairman, and includes the following members:—Prof. I. Bayley Balfour, Dr. W. Bateson, Prof. V. H. Blackman, Prof. F. O. Bower, Mr. R. D. Cotton, Prof. H. H. Dixon, Prof. J. B. Farmer, Capt. A. W. Hill, Prof. W. H. Lang, Sir Daniel Morris, Mr. J. Murray, Mr. G. H. Pethybridge, Sir David Prain, Dr. A. B. Rendle, Mr. H. N. Ridley, Prof. R. A. Robertson, Sir A. E. Shipley, Prof. W. Somerville, and Dr. H. W. T. Wager. Dr. E. J. Butler, late Imperial Mycologist, Director of the Research Institute, Pusa, and Agricultural Adviser to the Government of India, has been appointed Director, and has started work at the headquarters of the Bureau, 17–19 Kew Green, Kew (telephone Richmond 603). The Bureau will work broadly on the lines of the existing Imperial Bureau of Entomology at South Kensington, and will aim at doing for the other great class of destructive agencies in agriculture, namely, the diseases and blights of plants caused by fungi, what the older Bureau has so successfully done in regard to injurious insects. It will be a central agency for the accumulation and distribution of information and for the identification of specimens sent in from all parts of the Empire.

DR. R. H. PICKARD, principal of Battersea Polytechnic, has been appointed director of research to the British Leather Manufacturers' Research Association.

IN the November issue of *Man* Miss M. E. Durham supplements Dr. W. Crooke's article (Journal of the Royal Anthropological Institute, vol. xlix.) on nudity in India by some notes of similar practices in North Albania. When a new house is built and ready for habitation, the hearth has to be kindled for the first time ceremonially. The fire is laid and the master of the house strips stark naked, enters the house, and ignites the fire by firing a pistol into it, after which the family takes possession of the house. When a new pair of oxen are yoked together for the first time the owner must be nude when he ploughs the first furrow. Miss Durham also notices that there is no feeling against nudity in the case of men crossing rivers by the aid of inflated sheepskins or of those in charge of ferries. The above two cases, which she regards as probably the only cases of ritual nudity in Europe, if, indeed, they are still practised in a region devastated by war, are deserving of record.

MR. C. G. E. BUNT discusses in *Ancient Egypt* (1920, part iv.) the genesis of Coptic twists and plaits, with the result that he traces them to Sumerian origin. Prof. Flinders Petrie sums up the question thus: "These conclusions on the Sumerian being the earliest forms of the twists and plaits accords with other facts of their distribution. The formula which seems to agree with all the cases is that the twist and plait is a Central Asian motive (see the wickerwork screens in Kirghiz tents); that from there it passed down the Euphrates, also into Syria, and first into Egypt under Hyksos influence. Plaits and twists were unknown in Italy until the Dacian captives were brought in and set to mosaic work; plaits were brought from the north into the basketwork capitals of Justinian, and the round plait in architecture only occurs in true Gothic work in Italy, the Lombard plait being angular, rushwork and not osiers. In Ireland the spiral is alone in the pagan age, and the plait only comes in after the Norse influences of the Christian period."

AN interesting programme was presented at the meeting of the Association of Economic Biologists held in the Imperial College of Science on Friday, December 10. Sir David Prain occupied the chair, and the first portion of the meeting was devoted to the exhibition of specimens. Dr. B. M. Bristol, of Rothamsted, showed a number of very beautiful pure cultures of algæ on solid media, obtained from the soil of the famous Broadbalk wheat-field, the algal flora of which she is studying. Dr. S. G. Paine exhibited bacteria with flagella stained by a new method, and also a convenient new pattern of incandescent lamp which he has devised for microscopic work. Mrs. Alcock showed specimens of Douglas fir attacked by *Phomopsis pithya*, Lind., a parasitic fungus new to this country; and Mr. W. B. Brierley exhibited a fine photograph of Dr. Erwin F. Smith, the eminent American pathologist. Mr. W. J. Dowson then read his paper on "Problems of Economic Biology in British East Africa," dealing especially with the relations of plant disease to climatic conditions. A second paper was read by Dr. M. C. Rayner on "Nitrogen Fixation in the Ericaceæ," in which a convincing case was stated for the fixation of nitrogen by the mycorrhizal fungus in this genus of plants. The papers were discussed by Dr. E. J. Butler, Mr. F. T. Brooks, Prof. V. H. Blackman, and Dame Helen Gwynne-Vaughan.

IN Bulletin 313 of the Agricultural Experiment Station of the University of Wisconsin Prof. L. J. Cole and Miss Sarah Jones discuss the occurrence of red calves in black breeds of cattle such as Aberdeen-Angus, Galloway, and Holstein-Friesian. They point out that red is recessive to black, and was introduced by crosses in the early days of formation of the breeds, when little selection for colour was practised. The more rigid selection for colour at present in vogue has not yet succeeded in eliminating the recessive factor for red from the germ-plasm. Such a simple account of the cause of the persistent sporadic reappearance of red is valuable for practical breeders who have no knowledge of the scientific principles of heredity. It serves to eradicate many erroneous ideas as to the nature of these occurrences.

IT was ascertained by Blacklock and Carter at the Liverpool School of Tropical Medicine in 1919 that the indigenous British mosquito, *Anopheles plumbeus*, could be infected with the malarial parasite *Plasmodium vivax*. As a consequence of this discovery the Mosquito Investigation Committee of the South-Eastern Union of Scientific Societies was asked by the Ministry of Health to aid in discovering the exact distribution of this mosquito in England and Wales. In its Circular No. 4 this committee explains the effort it is making to conduct an inquiry into the distribution of *A. plumbeus* within the areas to which the activities of its affiliated societies extend. The circular gives detailed descriptions of the egg, larva, and fly of *A. plumbeus* and of its breeding-places, illustrated by plates of figures reproduced from Lang's "Handbook of British Mosquitoes," issued by the British Museum, and from Blacklock and Carter's paper in the *Annals of Tropical Medicine and Parasitology*. These, with further information concerning habits, distribution, collection, etc., should make the circular useful to the amateur and efficient for its purpose. It is clear that the Ministry of Health has a keen ally in this committee of the South-Eastern Union of Scientific Societies.

THE October issue of the Tropical Diseases Bulletin, published by the Tropical Diseases Bureau, consists of a Sanitation Number, and comprises extracts from and notes on papers appearing in various scientific journals and official reports. The matter is divided under several heads, namely: Disease Prevention (chiefly Malaria), Conservancy, Water, Milk, Smallpox Vaccination, Rat Destruction, Disinfection, Vital Statistics, and Book Reviews. Most of the notes and extracts are very brief, but appear to bring out the more salient points of the original papers, and will undoubtedly serve as a very useful guide to the student of this particular subject. The paper to which most space is given is one by Sir Alexander Houston on water and sewage purification, reprinted from the Reports of the Progress of Applied Chemistry. This paper, dealing chiefly with water and sewage problems in this country, has, perhaps, only an indirect bearing on tropical hygiene, but it is, nevertheless, highly important from that point of view in that it deals largely with questions of chlorination of water and with algal infection. An interesting point is that the author states that he has recently discovered a means of preventing or removing the residual or, as he describes it, "iodoform" taste in chlorinated water by means of a small dose of potassium permanganate (2 lb. to 8 lb. per 1,000,000 gallons). This question of taste has always been one of the difficulties in the way of the successful chlorination of water and the cause of many complaints from consumers, and Houston's taste-eliminating process should prove an immense boon where chlorination of water is necessary. How much more pleasant it would have been to the troops during the war if this discovery had been made half a dozen years ago!

THE Geological Survey has just issued another portion of the Memoirs on the Economic Geology of the Central Coalfield of Scotland, the present volume dealing with the fourth area into which the coalfield has been divided; this includes an area of rather more than 40 square miles, extending 10 miles to the west of Glasgow, both north and south of the Clyde. The district is not of any great economic interest; the ironstones are, for the most part, thin, and practically all the workable portions have been exhausted. Most of the coal-seams, too, are thin, and the quality is in many cases inferior. There are, however, two features of high geological interest, namely, the great local thickening of one of the coals, known as the "Quarrelton thick coal," described as "certainly the thickest single accumulation of coal-matter in Britain," and the remarkable crush-zone known as the "Paisley Ruck." Both these are fully and exhaustively discussed in the memoir.

SOUTHPORT Meteorological Observations for 1919 have recently been published by the County Borough, the report being prepared by Mr. Joseph Baxendell. Hourly whole-year normals of several elements for periods ranging from ten to twenty years are given in diagram form as a frontispiece. The tabular statistics of air-pressure, temperature, sunshine, rainfall, wind direction and velocity, with other subsidiary matters, are given for several hours for each month and for the year with the differences from the normal. An outstanding feature of 1919 was the remarkable prevalence of winds from the north-westward, their duration surpassing that of winds from any other direction, which is quite unprecedented since the commencement of autographic records in 1898. The March of 1919 was the wettest experienced during the forty-eight years' existence of the observatory, and this was followed by a deficient rainfall for eight consecutive months. Atmospheric pollution is regularly measured at two different spots in Southport, and an attempt is made to compare the results with those from other places, but the observations to hand are by no means numerous. The recorded meteorological observations are of the highest order, and the report from year to year contains usually some special discussion—a feature in advance of the returns from most corporations. In the report for 1919 the special discussion is the diurnal variation of air-pressure from the averages of ten years, and associated with this is the range of the diurnal sea-breezes. Ten years are too few for such a discussion, and certain elements of irregularity cannot be eliminated in so short a period.

THE *Résumé* of the communications made to the French Physical Society on November 19 contains a short description of the spectrograph for ultra-violet work constructed by MM. J. Duclaux and P. Jeantet. The lenses of the collimator and camera are of quartz and the prism is of water between quartz plates. The whole is enclosed in a wooden box which is sufficiently gas-tight to allow non-absorbing gases to be substituted for air. With a water prism of 70° it is possible to photograph spectral lines from 6000 to 1850 tenth-metres. For light of wave-length less than 2000 water is more transparent than quartz, and throughout the whole of the ultra-violet the dispersion of water is greater than that of quartz. With a condenser spark the line 1862 may be photographed on a Schumann plate which is almost devoid of gelatine in 5 seconds. The only inconvenience of the water-prism for this work is the considerable change of the refractive index with temperature.

THE discovery of the nickel-steels of the invar type, possessing a very small coefficient of expansion, has had many valuable applications in metrology, but careful study has proved the existence of residues, temporary or permanent, much resembling the anomalies in the expansion of glass. The cause of this instability has now been proved by M. Ch. Ed. Guillaume (*Comptes rendus*, November 29) to be the carbon in the alloy. The index of instability is arbitrarily defined as the elongation, in microns per metre, of a bar submitted to a heating for 100 hours at 100° C., the only previous treatment being the air-cooling after forging. For an invar of average composition in the natural state this index has been found to be of the order of 30. The examination of a series of bars with gradually increasing and exactly determined percentages of carbon showed that the index of instability was a regular function of the carbon content, and approached the origin of the co-ordinates as the carbon approached zero. Cementite was regarded as the probable cause, and hence the addition of a metal having a higher affinity for carbon, such as chromium, tungsten, or vanadium, suggested a probable solution of the problem of removing, or at least of reducing, the cementite. Experiments made in this direction have proved successful, the addition of chromium, for example, to an invar containing 0·1 per cent. of carbon producing an alloy in which the index of instability is reduced to one-tenth of its original value. As the price of the increase in stability, the coefficient of expansion is slightly raised.

THE meeting of the Illuminating Engineering Society on December 14 was devoted to the presentation of reports on progress and to exhibits illustrating novelties in lighting. The number of committees working under the society has been increased, recent additions being committees to deal with progress in gas lamps and lighting appliances and with the measurement of light and illumination. Progress in the latter field was illustrated at the meeting by the exhibition of a new form of illumination-photometer enabling illumination to be determined by the inspection of a series of apertures of graded brightness without any manipulation being needed to secure a reading. Such instruments seem likely to be specially useful for demonstration purposes. Other features of interest among the exhibits included a demonstration of the latest form of Sheringham "artificial daylight" apparatus, which is now being made in a standardised form, and some small electrical gas-filled lamps with opal glass bulbs, shown by the Edison and Swan Electric Co. This firm also loaned for exhibition some new neon lamps of a very interesting character. Formerly such lamps, the light of which depends upon an electrical discharge through rarefied neon gas, required a relatively high voltage. But the lamps exhibited resembled an ordinary glow lamp in appearance, and could be inserted in an ordinary lamp-socket on 220 volts. The lamp exhibited was stated to consume only 5 watts, but the light consists of a relatively feeble orange glow at the negative electrode. It is thought, however, that such lamps will be useful as pilot lamps, etc., and in cases where only a very low candle-power is needed. At the conclusion of the meeting the chairman (Dr. A. H. Levy) announced that Mr. J. Herbert Parsons had accepted the presidency of the society in succession to Mr. A. P. Trotter.

THE results of recent investigations on the theory of development by Mr. A. H. Nietz, of which Dr. Mees, of the Kodak Research Laboratory, recently gave an account at the Royal Photographic Society, are given in the current (December) issue of the society's Journal. It is found that the "reduction potential" of a developer can be measured by finding the concentration of bromide required to give the same rate of change of depression of density, and this is the method for its estimation that is least subject to error. The relative reduction potentials of sixteen developing agents are given, beginning with ferrous oxalate as 0·3 and ending with diamidophenol as 30 to 40. The author says that it appears to be well founded that (1) the maximum density tends to increase with increasing reduction potential; (2) no definite relationship can be shown between the time of appearance and the reduction potential, nor is the velocity constant affected by the potential in any regular manner; (3) while the speeds of emulsions vary with the developer employed, they are apparently no function of the reduction potential; and (4) the fogging power of a developer also appears to have no relation to the reduction potential. The author also draws conclusions as to the effect of the structure of the molecule of the developer on its reduction potential. The amino-phenols are the most energetic, the hydroxy-phenols come next, and the amines follow. The introduction of a methyl group into the nucleus or into an amino-group raises the energy, but two methyl groups are not always more effective than one; nuclear substitution of a halogen in the hydroxy-phenols raises the energy, and other less general statements are deduced. The growth of the image and of the fog do not generally follow the same law; evidence was found that fog is practically absent from the high densities and increases as the image density decreases, but bromide restrains the fog more than it restrains the image. Other allied subjects are considered.

MESSRS. J. WHELDON AND CO., 38 Great Queen Street, W.C.2, have just issued a noteworthy catalogue (New Series, No. 91) of books in the various branches of zoological science. It refers to upwards of 2000 volumes, classified under the subjects of Protozoa and micro-zoology, Cœlenterata, Echinodermata, Annelida, Crustacea, Insecta and Arachnida, Mollusca and Polyzoa, parasitology, evolution, heredity, and hybridity. In addition, there is a list of sets and long runs of scientific periodicals which Messrs. Wheldon offer for sale.

A NEW edition of "The Resources of the Sea," by Prof. W. C. McIntosh, is announced for publication by the Cambridge University Press early in January. The work has been carefully revised and brought up to date. A chapter on the labours of the International Fisheries Council is promised.

Our Astronomical Column.

A NEW COMET.—Mr. Skjellerup, of Cape Town, has discovered a new comet 1920*b*; its position on December 13 at 12h. 57·4m. G.M.T. was R.A. 8h. 55m. 16·07s., S. decl. 9° 1′ 48″; daily motion + 4m., N. 1° 19′. The comet is moving towards Regulus, and coming into a favourable position for northern observers. Its magnitude at discovery was 10½. It will be remembered that Mr. Skjellerup discovered another comet a year ago; it was, however, unfavourably placed, and very few observations were secured.

Mr. Van Biesbroeck observed this comet at Yerkes Observatory on December 17d. 20h. 19·8m. G.M.T., R.A. 9h. 16m. 59·6s., S. decl. 3° 10′ 7″. The average daily motion from December 13 to 17 is +5m. 3s., N. 1° 22′. The comet is evidently not very distant from the earth; its motion is direct, and it will pass the ascending node in about ten days. It is visible in a small telescope.

TABLES DU MOUVEMENT KÉPLÉRIEN.—Ever since the enunciation of Kepler's laws efforts have been made to simplify the determination of true anomaly and radius vector in terms of the time. Many of the methods given are ingenious and useful, but none appear to give so rapid a solution as extended tables. Dr. M. F. Boquet, astronomer of the Paris Observatory, has just published a very useful volume with the aid of a grant from the Académie des Sciences; it gives for values of e ascending by intervals of 0·01 from 0·00 to 0·50, and for values of v ascending by intervals of 1° from 0° to 180°, the values of M and $\log r/a$ to three and five decimal places respectively, together with columns of differences for the variation of v and e. It is thus quite a short computation to find v and $\log r$ for a given value of M to 4″ and to the fifth decimal place respectively. Examples are also given showing how the difference-columns may be utilised to obtain seven-figure accuracy by a straightforward computation. These tables will be a boon to all who desire to calculate ephemerides of short-period comets or minor planets. *A propos* of the latter point, it may be mentioned that the ephemeris of Ceres given in NATURE of December 9 is found to need the large correction of *minus* 4m. 40s. in right ascension. This large discordance emphasises the inconvenience resulting from the discontinuance of the accurate ephemerides of the four chief asteroids formerly published in the Nautical Almanac.

THE UCCLE OBSERVATORY.—Tome xiv., fascicule iii., of the *Annales de l'Observatoire Royal de Belgique* shows that a considerable output of work went on at the Uccle Observatory even during the dark days of war. It contains micrometric measurements of 172 double stars made with the 38-cm. equatorial by G. van Biesbroeck. The mean result for Castor (epoch 1914·142) is 219·59°, 5·30″. The distance shows a marked diminution since about 1890, when the maximum, 5·76″, was reached. So far as it goes, the above observation favours Mr. Lewis's minimum ellipse, the period of which is 310 years.

The *Annales* also contain a very fine series of cometary observations extending from 1913 to 1919; for example, Delavan's comet of 1913 was observed for position on seventy-three nights, and its magnitude determined on thirty-two nights. It remained a naked-eye object for nearly six months, attaining a maximum of 2·8 magnitude in mid-September, 1914. Among other methods that of extrafocal images was largely used. The comparison stars are thus expanded into discs, which renders them more readily comparable with a diffused body like a comet.

Colloid Chemistry.

By PROF. W. C. McC. LEWIS.

COLLOID chemistry—the science which deals with the phenomena occurring at the interfaces which separate two contiguous phases, such interfaces being very large in extent relatively to the actual masses of the phases themselves—stands in a rather peculiar position. Numerous colloid problems are encountered by workers who in many cases fail to realise the significance of their observations from the point of view of colloid chemistry itself. The scope of the subject is so wide that it is not surprising to find the literature exceedingly scattered, and part of it not easily accessible. Many of the results and observations are rendered difficult to interpret, or even lose the greater part of their value, through insufficient attention having been paid to considerations which a general knowledge of colloid chemistry as a science would have suggested. For similar reasons there has been a considerable amount of overlapping and, in some cases, a distinct lack of agreement in results, which probably has its origin in unsuspected dissimilarity in the conditions employed. With the literature, scientific and technical, in this state it is evident that considerable good might be done by attempting to correlate such observations and results with the object of impressing the essential unity of the subject upon those engaged in problems apparently diverse. Such an attempt at co-ordination has been made by the Colloid Committee of the British Association, which has just issued its third report.[1]

This report, following the plan already adopted in the two previous reports, contains the subject-matter arranged under two heads: (1) classification according to scientific subject, and (2) classification according to industrial process. Under the first head the following subjects have been dealt with: Colloid Chemistry of Soap Solutions; Ultra-microscopy; Solubility of Gases in Colloidal Solutions; Electrical Charge on Colloids; and Imbibition of Gels. Under the second head we find: Industrial Applications of the Imbibition of Gels; Colloid Problems in Bread-making; Colloid Problems in Photography; Cellulose Esters; Colloid Chemistry of Petroleum and of Asphalt; Varnishes, Paints, and Pigments; and Clays and Clay Products.

Merely to read over the list of industrial subjects dealt with in this and in the two previous reports is sufficient to indicate the extraordinarily wide technical field in which colloid considerations play a decisive part. At the same time one cannot but be struck by the predominance of empiricism in almost all cases, and, consequently, the urgent need there is for each industry to investigate its own colloid problems on scientific lines. The Committee will have done something if it succeeds in emphasising this fact.

Unfortunately, at the present time the retort may well be made that broad scientific principles in colloid operations and processes are few, and that even the simplest colloid phenomenon is by no means completely understood. By way of illustration, let us take the case of the stability of a colloidal metal in a dispersing medium such as water. Are we to take it as true that small particles consisting of pure metal only are capable of permanent distribution in a pure solvent, or is it always necessary to have some "impurity" present to stabilise the system? We know that a finely divided metal such as that considered carries an electric charge, but we have not any notion of its magnitude; and although we know that it can be discharged, the mechanism is not altogether clear. Does the stability of the colloid system depend on the existence of the charge alone or upon the magnitude of the interfacial tension round each individual particle, or upon both effects; and, if so, in what manner? Is there a real limiting size to such particles, and, if so, what opposing agencies determine the size and how do they operate? In the peptisation of such particles, say by the addition of gelatin, does the peptiser form an actual coating round each individual? If so, what are its properties, and what relation does the amount of bound peptiser bear to that still left free in the liquid? We know that peptising effects are highly specific. What determines the specific nature of the effect? Again, what is the mechanism of coagulation, and why are certain coagulations reversible and others not? Numerous queries of this kind naturally occur even in connection with a problem which is only one of many included in the term "colloid chemistry," and it may be said with confidence that to answer at all adequately some of these queries will require many years of intensive scientific investigation. Further, it must be borne in mind that several technical processes in active operation at the present time depend directly upon such phenomena as stability of dispersed systems, peptisation, and coagulation. It is obvious that effective control and ultimate extension of such industries must involve a scientific knowledge of what is taking place.

Let us turn for a moment to some of those aspects of colloid phenomena upon which we may be said to possess some real *quantitative*, though necessarily incomplete, knowledge. First of all we have Willard Gibbs's theoretical investigation of the influence of an interface upon the concentration of gaseous and dissolved substances. A small section of Gibbs's work has led to the only quantitative law of adsorption by capillary forces which we possess, and it seems not improbable that other generalisations still lie unheeded in his famous essay. Next we have Donnan's quantitative investigation of the effect of a chemically inert membrane upon the distribution of electrolytes when electrolytic colloidal material is present on one side of the membrane, leading to the phenomena of membrane hydrolysis and membrane potentials. To this we must add the application of Donnan's method of treatment in the hands of Procter and of Wilson to the imbibition of gels and the process of vegetable tanning. Next we have the quantitative investigations and generalisations of McBain, of Bayliss, and of Pauli upon the composition and behaviour of colloidal electrolytes, such as the soaps and the proteins, as a function of the dilution of the system. We have, too, the work of Perrin, of Gee, and of Bancroft on the mechanism of electrical endosmose. We have the beginnings of a science of electro-capillarity in the work of Lippmann and of Helmholtz. Our knowledge of the molecular and atomic mechanism of condensation upon surfaces has been greatly increased by the novel ideas of Langmuir and of Harkins—a subject of the utmost importance in connection with heterogeneous catalysis generally. We know something, though not a great deal, about such phenomena as the viscosity of colloidal solutions, the rigidity of surface films, the mechanism of lubrication, the Liesegang phenomenon, and other typically colloid-chemical problems. The fact is that an enormous field exists the scope of which is by no means realised

[1] Department of Scientific and Industrial Research. British Association for the Advancement of Science. Third Report on Colloid Chemistry and its General and Industrial Applications. Pp. ii+154. (London: H.M. Stationery Office, 1920.) Price 2s. 6d. net.

by scientific investigators in general or by those actually engaged in technical problems which involve, either partly or wholly, considerations of a definitely colloid nature.

The reports of the British Association Committee on Colloids have dealt with a number of the subjects referred to above, and also in some detail with a number of industrial operations involving colloid chemistry. Several scientific subjects and technical applications have not as yet been included. It is hoped that a number of these will form the subject-matter of the fourth report.

A New Problem of Coastal Navigation.

In coastal navigation there is no problem of greater general utility than that of fixing positions by means of "cross-bearings" of two terrestrial objects. If, for instance, we have one object bearing due north and a second bearing due east, we have but to lay down the bearings reversed, south from the one and west from the other, and the point of intersection of the two lines of bearing fixes the position of the ship.

When, as is often the case, only one light is available, it has generally been assumed that no more information could be obtained from its observed bearing than a single line of bearing, somewhere upon which the ship's position must lie. But a little work recently published in Australia[1] by Capt. H. H. Edmonds, of the British Mercantile Marine, introduces us to a comparatively novel use for a single light, for he shows how by three bearings, with the intervals between the bearings noted, we may deduce that most valuable piece of information, the actual course under the influence of wind and current which is being made good "over the ground."

The problem is not wholly new, for in its most general form questions to be solved by protraction have been proposed in recent years in the Board of Trade examinations for masters and mates, but in much too complicated a form to be of service in actual work at sea. The advance effected by Capt. Edmonds lies in the application of a simple form of table, reference to which gives the course made good in a moment with no more trouble than the division of one quantity by another.

In the construction of the table it is assumed that the intervals in azimuth are equal, the times of the three observations being carefully noted. One of these being divided by the other, a "ratio" is obtained which serves as an argument of the table.

The use of the table will easily appear from one of the examples given: "A light bore N.W.; after a time-interval of 39 minutes it bore W.N.W.; after another time-interval of 21 minutes it bore W."

A portion of the table to be employed is given below:

Bearing interval 22° 30'.

Course angle.	Ratio.
31°	1·884
32°	1·839
33°	1·796

The solution is given as follows: "Dividing the greater time-interval by the lesser, we obtain a ratio 1·857; with this ratio, under bearing 22½°, we obtain the course-angle 32°, which, allowed forward of the first bearing, gives course made good N. 13° W."

The table of the text-book, as has been shown, proceeds upon the assumption that the intervals in azimuth should be equal. A still more advantageous form of table, it would seem, could be obtained by taking the observations at equal intervals of time, with differences of bearing in general unequal. This form of table presents at least two very attractive features: first, that we have no ratio to calculate, and, secondly, that it is much simpler in practice to observe a bearing at a given time by watch than to wait, watch in hand, at the compass until a given bearing comes on. For air navigation in particular such a table should be invaluable, since it is quite unnecessary to fix the identity of the particular point observed, and, indeed, the problem has already engaged the attention of some of the able men who have taken up the problems connected with the navigation of the air. In a recently published work by Lieut. Dumbleton[2] the following passage occurs, taken apparently from a lecture by Squadron-Leader Wimperis before the Royal Aeronautical Society: "How is one, then, to determine the course being made good? Perhaps the best method is to take times and bearings of the object as it passes through the points E, F, and G, such that the time from E to F is equal to the time from F to G."

The lecturer goes on to describe a method of solving the problem by protraction, suitable, perhaps, for an airship, but scarcely practicable probably for a heavier-than-air machine.

The following extract shows the form which such a table, devised for equal differences of time, would assume:

Angle of Inclination to First Line of Bearing.

Difference between first and second bearings.	Difference between second and third bearings.					
	56°	F.	54°	F.	52°	F.
38° ...	35·2°	0·74	36·5°	0·76	38·0°	0·78
36° ...	34·7°	0·71	36·0°	0·73	37·4°	0·75
34° ...	34·0°	0·68	35·3°	0·69	36·7°	0·71
32° ...	33·2°	0·64	34·4°	0·66	35·7°	0·67
30° ...	32·1°	0·60	33·3°	0·62	34·6°	0·64

The column marked F requires, perhaps, some explanation. The primary object of the table is to give the course made good. But when at first bearing the distance from light is known with reasonable accuracy, the distance in final position is obtained by multiplying first distance by factor F. The following example will serve to illustrate the use of the table:

From a ship steaming N. 25° W. 16 knots, the Smalls Light (lat. 51° 44′ N., long. 5° 40′ W.) bore N. 26° E. Twenty minutes later the Light bore N. 59° E., and again after a further twenty minutes S. 67° E. Find true course made good.

For first difference of bearing we have $59° - 26° = 33°$, and for second $113° - 59° = 54°$.

Entering table with 33° on left and 54° at top of the page, we have the angle 35° nearly.

This angle applied to the first bearing, N. 26° E., gives N. 9° W. as true course made good over the ground.

To illustrate the use of the factor F, let us suppose that by means of the line of position from a star observation or otherwise, distance at first bearing was found to be 10 miles. Then final distance $= 10 \times F = 10 \times 0{\cdot}68 = 6{\cdot}8$ miles.

[1] "Course Angle Tables for Finding a Course Made Good." By H. H. Edmonds. (Sydney: Turner and Henderson.)

[2] "Principles and Practice of Aerial Navigation." By Lieut. J. E. Dumbleton. (London: Crosby Lockwood and Son.)

The position of the Smalls Light, it may be observed, is such that it offers special advantages for the application of the proposed method. A ship rounding the Land's End, bound for the Irish Channel, after passing the Longships Light, has a run of about 130 miles for the Tuskar Light, and towards the end the tidal currents set across the mouth of the Channel with considerable velocity. In such a case observations of the Smalls Light, should it become visible on the starboard bow, would be of considerable service in checking the course laid for the Tuskar.

H. B. G.

Late Keltic Remains from a Mendip Cave.

AN important series of Late Keltic objects has been brought to light by members of the Speleological Society of the University of Bristol in the course of investigations in a cave in the Mendips. The cave was first discovered in September, 1919, and the work of exploration, which has been done on most systematic lines, has been carried on throughout the past year. The finds, which were described by Mr. L. S. Palmer at a recent meeting of the Royal Anthropological Institute, included objects of worked bone and stone, bronze hubs and bands of chariot-wheels, bronze bracelets and finger-rings, iron slave shackles, an iron key, spindle whorls, and similar objects. A considerable amount of pottery was also found which in design and technique was comparable to that found in most Late Keltic settlements. It does not, however, exhibit the characteristic curvilinear motives, the chief decorative feature being in the form of an inverted C. Only three human bones were discovered. There was a large number of bones of domestic and wild animals. A peculiar feature of the discovery is that all these objects were found either on the surface of the floor of the cave or in a thin band of mud which constituted the uppermost layer. There was no evidence of earlier occupation or any trace of Roman occupation. These facts, taken in conjunction with evidence which points to occupation of the cave having taken place in abnormal circumstances, would suggest that the cavern was used as a temporary refuge.

The discovery is of great importance in connection with the question of the relations which subsisted between this country and the Continent during the Iron age. The character of the finds, and in particular the close affinity exhibited by the pottery to that of Brittany, pointed, in Mr. Palmer's opinion, to the site having been occupied by a tribe of the Brythons who migrated to this country from the north of France. The same people built Glastonbury Lake Village, and are known to have inhabited Wookey Hole, Worlebury Camp, and some hut circles on Brean Down, all of which are within a few miles of this cave. In support of his view Mr. Palmer pointed out that the hill forts in this area all face in a northerly direction, which would suggest that they were the van of a wave of immigration from the south. On the other hand, as Prof. Keith pointed out, the type of skull usually associated with this type of culture in the west of England differs essentially from the Breton skull, and the affinity between the pottery of this area and that of Brittany may well be the result of commerce rather than of immigration. It may be hoped that the further exploration of the site which is to be carried on during the coming year may produce fresh evidence to throw light upon a period concerning which our present knowledge is all too scanty.

Physiology at the British Association.

ON Tuesday, August 24, the Section of Physiology held a joint meeting with the Sub-Section of Psychology. At this joint sitting Dr. Rivers opened a discussion on the desirability of establishing a separate Section of Psychology. The address of the chairman of the Sub-Section (Dr. C. S. Myers) was on almost the same subject. Dr. Rivers gave an outline of the history of psychology in relation to the British Association, and showed that there had been a great increase in the number of papers on psychological subjects contributed to the Association. He pointed out that psychology had developed methods and problems of its own. At the end of the discussion Dr. Rivers moved a resolution: "That this meeting of the Section approves of the constitution of a separate Section of Psychology." This resolution was passed *nem. con.*, and it was referred to the committee of the Section.

At the same joint meeting Miss M. Smith and Dr. W. McDougall read a paper on "The Effect of Drugs on Fatigue." Fatigue was induced by sitting up all night for three successive nights, and the effect was studied by means of dotting circles on a moving tape and by memory tests with related words. The first effect of fatigue was to increase the efficiency, but after the first few days the efficiency showed a marked decline and remained below the normal for from sixteen to nineteen days. This showed that the effect of the loss of sleep extended for a considerable period after the loss of sleep had occurred. The drugs were given disguised so that they could not be recognised. Most of the experiments were with alcohol or opium. The action of alcohol was to decrease the efficiency except during the period of recovery, when a stage occurred in which alcohol caused the efficiency to approach the normal non-fatigued value. Opium caused an increase in efficiency which was more marked in the recovery stage. When the dotting and memory tests were carried out together alcohol caused them to vary together, and the subjective effect was not unpleasant, but opium caused one process to improve at the expense of the other, and the subjective effect was distinctly unpleasant.

On Friday, August 27, the Section of Physiology met the Section of Botany to discuss "Biochemistry and Systematic Relationship." An account of this discussion appears in the article upon the proceedings of the Section of Botany (p. 550).

Several of the meetings of the Section were held in the new buildings for the department of physiology, when the members of the Section had the privilege of inspecting the excellent accommodation for the department. At one of these meetings Prof. Haycraft demonstrated a new pulse recorder, which consists of a mirror resting on the artery, the records being made by photographing the movement of a spot of light reflected from the mirror.

Dr. T. Lewis read a paper on "The Relation of Physiology to Medicine." This was largely a plea for the development of the subject of human physiology. He pointed out the importance of a knowledge of physiology for rational medicine, but contended that it would be of greater value if more use were made of the human subject for illustrating the facts of physiology. The use of methods of examination applicable to the human subject should be extended, but, of course, the methods must be controlled by experiments on animals. Dr. Lewis finished his paper by appealing to the citizens of South Wales for an endowment for the department of physiology. As a graduate from South Wales, he felt the handicap due to lack of accommodation and of equipment; now that a good building had been provided he hoped that sufficient money would be forthcoming for its equipment and upkeep.

As a good example of the way in which animal experiments must be used to elucidate the physiology of the human subject Dr. Lewis's paper on "Auricular Flutter" may be quoted. This was a description of experiments on the heart of the dog. The time-relations of electrical changes in the auricle were traced, and they were found to differ from those of the auricle beating in its natural way. The evidence from the time-relations of the electrical changes points to a wave of contraction passing round the superior and inferior venæ cavæ. The normal beat consists of a contraction wave which spreads over the whole auricle, but in auricular flutter the wave travels down one side of the auricle round the inferior vena cava, and returns by the other side of the auricle to the superior vena cava. This establishes a circus movement which continues indefinitely. The wave of excitation reaches each part of the auricle at a sufficient interval after the previous contraction to fall outside the refractory period; hence the series of quickly following circus movements. The normal contraction ends because the wave of contraction spreads fan-like over the whole auricle, when it reaches the limits of the auricle: it ceases because the wave of excitation is dammed by the refractory period of the contracting auricle.

Miss E. Bedale, in collaboration with others, read a paper on "The Energy Requirements of School-children." The measurement of energy was attempted in two ways. The first consisted in obtaining diet-sheets prepared by the pupils on which they recorded the weighed amounts of the various food materials eaten. These diets were evaluated by analytical data, and the energy-value of the diet was obtained in that way. The second method was to measure the energy expenditure by means of the respiratory exchange. The basal metabolism was measured during sleep. Measurements of the respiratory exchange were made during various forms of activity and the daily expenditure was estimated by a calculation involving the amount of time occupied in the different forms of activity. The two energy values did not agree, the intake of energy being greater than the expenditure. It was left an open question as to how much of the lack of agreement was due to errors in computing the energy output in the various forms of activity during the day.

Prof. Waller gave some figures on an allied subject in which he measured the energy expenditure by the output of carbon dioxide. He contrasted a man in training with an untrained man running the same distance at the same speed. Assuming that the basal metabolism of the two men was the same, the untrained man expended double the amount of energy in doing the same work.

Prof. Herring recorded measurements showing the effect of pregnancy on the various organs of the white rat. The animals were from a standard litter, and kept under identical conditions except for the occurrence of pregnancy in some of them. Most of the organs showed a slight decrease in weight; the only ones that showed an increase in weight were the liver and the adrenals. The increase in the former shows the great importance of metabolism during pregnancy. The increase in the latter is probably in the cortex, and not in the medulla.

Dr. Edridge-Green read a paper on "The Prevention of Myopia," in which he stated that the exciting cause of myopia is an increase in intra-ocular pressure. Games such as cricket, football, golf, etc., do not cause myopia, but severe strains such as lifting heavy weights, especially with the eyes pointing downwards, should be avoided.

Prof. Waller recorded some further observations on "The Emotive Response of the Human Subject." The response is usually confined to the hand and foot, but a few individuals show it on the forearm and leg. The reaction appears first on the hand (2″) and then on the foot (3″). If it occurs elsewhere it is delayed as long on the arm as on the foot (3″), and shows a longer latent interval on the leg (4″).

Prof. Waller presented the report of the Committee on Electromotive Phenomena in Plants. The zone of growth in iris is at the base of the leaf, and in anemone at the apex of the plant. When an induction shock is passed through an active growing tissue the resultant electrical change is always from the more active to the less active portion in the plant-tissue, no matter in which direction the stimulating current is passed. In dead tissues the current produced after stimulation is small, and always in the direction of polarisation.

Botany at the British Association.

THE diversified character of modern botany was well exemplified in the programme of the Cardiff meeting, and the *rapprochement* of the sciences was evidenced by the three joint discussions in which the Section took part. Joint sittings have become an important feature of recent years, and in this reflect the tendency of modern research to overstep the necessarily arbitrary boundaries of the so-called sciences and to combine with other workers on the border-line problems.

Thus it is not surprising to find botanists co-operating with zoologists and geologists to consider whether Mendelian work and palæontological evidence show as yet any sign of giving mutual support to the conclusions derived from each line independently.

The joint discussion with the physiologists and chemists entitled "Biochemistry and Systematic Relationships," presided over by Miss Saunders, president of the Botany Section, aimed at considering whether the present state of knowledge indicates any definite ratio between biochemical constitution and morphological expression—that is to say, does biochemical investigation show a chemical relationship in the forms which have long been grouped together on morphological grounds? The discussion was introduced by a paper by the Hon. Mrs. Onslow, wherein the possibility of expressing reproductive and vegetative characters in chemical terms was explored; lines of plant-metabolism were considered and suggestions made as to correlations between the evolution of the families of flowering plants and the presence of oxygenases, and the distribution of anthocyan pigments and of flavones was discussed. The papers and open discussion which followed indicated the importance of the new line of work, inasmuch as a considerable correspondence of chemical and morphological relationship had been established, but laid stress also on the necessity for extreme carefulness in its application in view of the diversity in many cases of chemical reactions in closely related forms.

Dr. F. F. Blackman contributed a paper on "The Biochemistry of Carbohydrate Production in Plants from the Point of View of Systematic Relationship," in which the distribution of the primary products of the photo-reduction of CO_2 in different groups of plants was traced, pentoses being the basis of the succulent habit, and the diversity of the condensation products, saccharose, starch, and inulin, was considered in relation to species and families. Emphasis was laid upon Reichert's work on the individuality of the starch-grains of every species of plant, and of its bearing on the chemical specificity of protoplasms. Prof. G. H. Nuttall followed with a paper entitled "Precipitin Reactions as a Means of Determining Systematic Relationships in Animals and Plants," in which it was pointed out that both animal and vegetable albumins retain certain chemical properties which persist, while the animal or plant to which they belong undergoes a phylogenetic morphological change, and that qualitative precipitin tests carried out with different albumins give a measure of the degree of relationship existing between forms that have descended from a common stock. The contribution of Mr. J. Barcroft (president of Section I) correlated the properties of the oxygen-carrying power of blood, essentially the properties of hæmoglobin, with the functions and habits of the animal in question rather than with its phylogeny, comparing in particular the oxyhæmoglobin equilibrium of fishes living in different habitats.

The semi-popular lecture which has become a feature of the Botany Section was delivered this year by Prof. Chamberlain, who came from Chicago to do so at the invitation of the committee. His eye-witness account of his adventurous acquaintance with the Cycads of the world delighted the audience no less than the beautiful lantern-slides which accompanied it.

Amongst other descriptive accounts of vegetation may be mentioned that of Prof. Chodat on some aspects of plant ecology and biology in Paraguay; that of Mr. Kingdon Ward on the distribution of floras in south-east Asia as affected by the Burma-Yunnan Ranges; that of Mr. Patton on the vegetation of Beinn Laiogh; and, lastly, a lantern demonstration of the Eastern Canadian Rocky Mountains by Prof. F. J. Lewis. Vegetation and soil surveys formed the subject of the joint meeting between the Sections of Botany and Agriculture, presided over by Prof. Keeble, president of the latter Section. Mr. G. W. Robinson dealt with the soil types of North Wales as revealed in the soil survey of recent years, and Mr. G. A. Fisher with soil acidity. Mr. Robinson suggested that, while uniformity in sampling and analytical methods should be secured, the classification of soils must depend on local conditions. In extreme humid conditions it would appear that differences due to geological factors tend to be obliterated. Large numbers of soil samples should be collected, and the types worked out from actual observations; correlation with geology may follow afterwards. The soil survey gives information as to *one* of the factors affecting plant-growth and, ultimately, agriculture in a particular area. The survey in its widest sense should take cognisance of all the other factors, including climate and soil-water conditions. The vegetation survey gives the results of the operation of all these factors.

Miss Wortham gave an account of the results of her survey of Anglesey and North Carnarvonshire, with special reference to the grass-lands, and showed that the plant-formations are closely related with the geological structure of the district. She traced the origin of grass-lands from upland moor, from woodland, and from the degeneration of lowland moor.

The botanical part of the discussion centred especially round types of grass-land, their importance in Wales and in general in agriculture, the possibility of fixing on some *standard* symbols of colours for ecological mapping, and the correlation of the various surveys. Prof. Stapledon, after discussing *Festuca agrostis* pastures in detail, laid stress on the need for a colour scheme which would allow of the representation of transition types. He also took up the question of the difficulties of the representation of arable, and suggested the possibility of using the weed flora in this connection. Lastly, Prof. Stapledon emphasised the immediate importance of hastening on the primary vegetation survey. As a result of the discussion, in which Sir Daniel Hall, Mr. T. J. Jenkin, Dr. E. N. Thomas, Mr. Morrison, and others took part, it became obvious that there existed a great need for co-operation among workers and more codification of observations. Steps were initiated with the view of bringing about this end.

The subject of geotropism, which has received considerable attention during the last few years, was considered on the Wednesday afternoon, when Dr. Harold Wager gave a paper on the geotropism of foliage leaves and their possible dia-geotropism. In a contribution entitled "Further Evidence for the Differentiation in Hydrion Concentration in Stem and in Root as the Explanation of Positive and Negative Geotropism," Prof. Small, in collaboration with Miss Rea, further developed his theory of the CO_2 balance as the cause of this differentiation in behaviour.

The only contribution to fossil botany was furnished by a paper by Mrs. Clement Reid on the history of the West European Pliocene flora as deciphered by the study of fossil seeds, in which, by the critical comparison of percentages which were then plotted as a curve, she demonstrated very clearly that seeds may be used to determine species and with strong probability for zoning purposes. Since Mrs. Reid's conclusions agree with those furnished by animal palæontology for known ages, they can be used for one unknown. The deductions from the curve based on the numerical study of plant species also agree with, and therefore support, many conclusions arrived at by stratigraphical and other evidence.

The president expressed special interest in a paper by Miss Blackburn on anomalies in microspore formation in Rosa and its possible connection with hybridity in the genus. The normal process had been examined in three species. Abnormalities were described in ten forms, two of which were known to be hybrids. The results suggested the possibility of determining the genetic constitution of forms by an examination of cytological phenomena.

Probably the most outstanding contribution of original work was supplied by Prof. Lloyd Williams, who gave a detailed account of his researches into the life-history of the Laminariaceæ, which demonstrated the existence of alternation of generations throughout the group.

Great interest was expressed in the progress reported by Mr. Martineau on the growth of pit-mound plantations in the Midlands, and a resolution was proposed by Sir Daniel Morris, seconded by Prof. Henry, and passed unanimously, urging State support for similar experiments in other parts of the country.

Notwithstanding the short time and crowded programme, the botanists were able to see something of the vegetation of the neighbourhood on their expeditions to the very beautiful country surrounding Cardiff.

University and Educational Intelligence.

LONDON.—On his resignation after twenty-seven years' service of the chair of botany at King's College the Senate of the University has conferred the title of emeritus professor of botany in the University on Dr. W. B. Bottomley.

The following doctorates have been conferred:—*D.Sc. in Geology*: Mr. H. A. Baker, an internal student, of University and Birkbeck Colleges, for a thesis entitled "On the Investigation of the Mechanical Constitution of Loose Arenaceous Sediments by the Method of Elutriation." *D.Sc. in Mathematics*: Mr. H. E. J. Curzon, an internal student, of University College, for a thesis entitled "The Reversal of Halphen's Transformation." *D.Sc. (Economics)*: Mr. E. H. J. N. Dalton, an internal student, of the London School of Economics, for a thesis entitled "Some Aspects of the Inequality of Incomes in Modern Communities."

Dr. Harriette Chick has been awarded the William Julius Mickle fellowship, of the value of 200*l*., in recognition of the important work she has carried out during the past five years on diseases due to defective nutrition.

DR. DAVID OWEN, senior lecturer in physics at the Birkbeck College, has been appointed head of the department of physics and mathematics at the Sir John Cass Technical Institute, Aldgate, E.C.3.

THE Drapers' Company has made a grant of 5000*l*. to the East London College (University of London) for the equipment of its new library. The remarkable growth and success of this University college in the Mile End Road, built up under the auspices of the Drapers' Company, form one of the outstanding features in modern educational activity. The undergraduates in the college now number nearly 600.

A MEETING for the purpose of considering the desirability of establishing a Federal Council of Associations of Teachers in Bristol, Gloucestershire, Somerset, and Wiltshire, held at the University of Bristol on December 4, was attended by representatives of numerous associations and institutions. Prof. J. Wertheimer was elected chairman, and it was decided that, subject to the approval of the majority of the associations represented, the council should be established. The objects of the council will be:—To bring together representatives of teachers of all types in order to give them opportunities of exchanging views, of becoming acquainted with one another's work, and of formulating, when desirable, expressions of opinion in regard to educational problems of general interest.

THE statement for the year 1919–20 of the Rhodes Scholarships Trust has been received. During that period 185 scholars, of whom 105 were from the British Empire and the remainder from the United States, were in residence; of this number 98 were freshmen. By the end of the year 32 of the scholars either completed the term of their scholarship or went down, in spite of which the present year opened with as many as 220 Rhodes scholars in residence. A record of the results achieved during the past year by holders of these scholarships is given, among which may be noted three students who were admitted to read for the degree of Ph.D. in natural sciences; while the books which have been published in the academic year by Rhodes scholars include a translation by Mr. H. L. Brose of Moritz Schlick's book entitled "Space and Time in Contemporary Physics."

IT is announced in the *Lancet* of December 18 that an anonymous donor has given 20,000*l*. for the endowment of the University chair of physiology at the Middlesex Hospital Medical School. The present occupant of the chair is Prof. Swale Vincent, who is well known for his publications dealing with the ductless glands and internal secretions. Prof. Vincent has one of the physicians of the hospital associated with him in his department in order to facilitate the introduction of new discoveries in the laboratories into medical practice in the clinical wards. This generous gift is a big step in the direction of the co-ordination of medical education with research and treatment which Lord Athlone, chairman of the hospital, is anxious to secure, and it will also form another bond in the relations between the hospital and London University. Of the six professorial chairs now existing in connection with the Middlesex Hospital that of physiology is the second to receive permanent endowment, the chair of physics having been endowed early in the present year.

THE first annual dinner of the Imperial College of Science and Technology, held on December 14, was an outward and visible sign of the common interests of the three constituent colleges—the Royal College of Science, the City and Guilds (Engineering) College, and the Royal School of Mines. The Marquess of Crewe, chairman of the governing body of the Imperial College, presided, and a large number of leading representatives of science and technology supported him. Several notable speeches were made in the course of the evening. Sir Alfred Keogh, rector of the college, said that long before the late conflict the college had been urging the principle of the relation of science to industry, which was the same thing as the relation of science to war, but neither the nation nor the Government had paid heed to it until the war broke out and it was found that war could not be waged without science. It was then that the three constituent colleges were able to render essential service in many fields. Lord Moulton said that science and technology were mutually complementary, science procuring the seed while technology used it to secure bountiful harvests for human needs. Sure success is built upon accurate knowledge such as the college diffuses in all its branches. The Marquess of Crewe remarked that the Imperial College has all the attributes of a university, and the courses taken by its students are no more specialised than those pursued by science students in the older seats of learning. He followed with much interest the progress of the University of London, and it was hoped that the college would advance on parallel, but not on identical, lines, both institutions agreeing to pursue the twin figures of knowledge and wisdom in still wider fields.

A CONFERENCE on recent advances in physics will be held in the physics laboratory of the University of Toronto between January 5 and 26 of the coming year. The principal event will be a series of eighteen lectures by Dr. L. Silberstein on "The Special and Generalised Theories of Relativity and Gravitation" and on some of the recent advances in spectroscopy and the theory of atomic structure. Einstein's theories of general relativity and gravitation, and the more recent theory of electromagnetism put forward by Weyl, will occupy some five or six lectures, and a similar period will be devoted to Bohr's quantum theory of spectra, Sommerfeld's relativistic theory of the structure of spectral lines, the Epstein theory of the Stark effect, and the lecturer's own theory of non-spherical nuclei. The course will be mainly mathematical in character. Dr. Irving Langmuir will deliver a short course of lectures on the theories of atomic structure and allied subjects from the chemical as well as from the physical aspect. Prof. E. F. Burton is giving a course of twelve lectures on the fundamental properties of colloidal solutions, which it is hoped will be as useful and interesting to manufacturers as to men of science. Sixteen lectures of a popular nature dealing with various aspects of recent researches on the structure of matter and on the origin and characteristics of radiation will be delivered by Prof. J. C. McLennan, who will deal chiefly with the results of the experimental investigations which have been made in numerous branches of the subject, concluding with an account of the production and uses of helium. The conference will be opened on Wednesday, January 5, by Sir Robert Falconer, president of the University of Toronto.

Societies and Academies.

LONDON.

Royal Society, December 9.—Prof. C. S. Sherrington, president, in the chair.—Lord **Rayleigh**: Double refraction and crystalline structure of silica glass. Although glasses in general have no double refraction, except that due to bad annealing, yet silica glass is found to have a doubly refracting structure which cannot be so accounted for, and must rather be regarded as crystalline. The double refraction is very weak, of the order of 1/60 that of crystalline quartz. In a mass of silica which has been melted, but not drawn or blown, the structure consists of doubly refracting grains with dimensions of about ⅓ mm., oriented at random. If the grained material is drawn out while soft, the grains are elongated into crystalline fibres or ribbons. Fused silica sometimes contains isolated, small inclusions of quartz with angular outlines which have escaped vitrification. These are conspicuous in the polariscope by the strain effects they produce in the surrounding glass.—Prof. J. W. **Nicholson** and Prof. T. R. **Merton**: The effect of asymmetry on wave-length determinations. (1) The apparent displacement of an unsymmetrical spectrum line caused by the finite resolving power of the spectroscope can be calculated on certain simple assumptions. (2) The displacement is independent of the actual widths of the lines. (3) It is considered that the general practice of measuring spectrum lines to a degree of accuracy far transcending the resolving power is not justified.—Prof. T. R. **Merton**: The effect of concentration on the spectra of luminous gases. Certain spectroscopic phenomena appear to be associated with the concentration of the radiating atoms in the source. An increase in concentration may result in a broadening of the lines, a change in the structure of the lines, and changes in the relative intensities. Sources containing lithium exhibit these three phenomena, and the broadening is familiar in sodium flames. A study has been made of the behaviour of sources containing sodium and lithium. The results seem to exclude a temporary association of atoms as the cause of the changes, for the addition of large quantities of sodium to a source containing a trace of lithium produces no change in the lithium spectra. Mixtures of hydrogen and helium have also been investigated. The broadened lines of both these elements from vacuum tubes excited by condensed discharges are accounted for completely by the electrical resolution of the lines by the electric fields of neighbouring charged particles.—Prof. E. **Wilson**: The measurement of low magnetic susceptibility by an instrument of new type. The paper deals with the design, construction, and working of an instrument for the measurement of susceptibility (of low order) over a wide range of magnetic force, and thus avoids the difficulty met with in the Curie balance, the defections of which follow the square law, and, in fact, limit the measurement of susceptibility of a given specimen to a very narrow range of magnetic force. The force due to torsion in a suspending fibre is replaced by an electromagnetic system in which the mechanical force is due to two components—one proportional to the magnetic force impressed upon the specimen and the other variable if the susceptibility varies. The expression for the susceptibility is that of the reciprocal of a resistance multiplied by a constant, and thus the instrument lends itself to great accuracy in the detection of variations in susceptibility.—Prof. W. T. **David**: The internal energy of inflammable mixtures of coal-gas and air after explosion. In the first part of this paper an empicical law of cooling of exploded mixtures of coal-gas and air contained in a closed vessel has been formulated. This is based upon measurements of the heat loss by conduction and by radiation made during the explosion and later cooling of the inflammable mixtures. In the second part the heat-loss measurements have been applied to the estimation of the internal energy of the gaseous mixtures at the moment of maximum temperature and at various stages during cooling.—Prof. A. **McAulay**: Multenions and differential invariants. The paper is a summary of the properties of a linear associative algebra suitable for electromagnetic relations, differential invariants, and relativity. There are *n* fundamental units, otherwise it is the same algebra as that considered in a paper by W. J. Johnson and read to the Royal Society on November 20, 1919.

Aristotelian Society, December 6.—Prof. T. P. Nunn in the chair.—Prof. W. P. **Montague**: Variation, heredity, and consciousness: a mechanist answer to the vitalist challenge. It was attempted to show that it is possible to point out a solution of the problems of phylogeny, ontogeny, and consciousness, statable in mechanistic terms, which provides full satisfaction to the demand of the vitalist that the purposive and psychic characters of life shall not be reduced to an epiphenomenal status of dependence upon blind processes. The occurrence of useful variations in the germ-plasm in greater frequency than is explicable on recognisable mechanistic principles may be explained by the conception of biological vectors, according to which the unpurposed, yet purposeful, products of telogenesis in the germ-plasm and in the brain, when occupied with creative imagination, are results of a system of protoplasmic stresses. The problem of the many hereditary determinants in the minute germ-cell may be met by conceiving the germ as a system of superforces or superimposed stresses which are the embodiments of a manifold of invisible intensive determinants equal in richness to the serial events of the germ's ancestral past, and capable of reproducing its pattern by induction during embryonic growth. The problem of explaining mind in physical terms was met by suggesting that the structure of conscious life is analogous to the structure of life in general, except that the system of cerebral superforces in which the past is stored up in the present is composed of traces of potential energy acquired by the brain through the transformation of the kinetic energies of sensory nerve-currents. A new category, "anergy," was proposed as a measure of the form of durational being produced whenever the energy of motion is transformed into the invisible or potential phase.

Linnean Society, December 9.—Dr. A. Smith Woodward, president, in the chair.—Prof. E. S. **Goodrich**: Hymenopterous parasites of grain-infesting insects.—L. V. **Lester-Garland**: Plants from Darfur collected by Capt. Lynes, R.N., with remarks on their geographical distribution.—Dr. B. Daydon **Jackson**: The Norsemen in Canada in A.D. 1000, with the plants they reported. The course followed by the Norsemen was narrated, from their colonies in Greenland, across

Davis Strait, to the north-east coast of Labrador, southward through Belle Isle Strait to the valley of the St. Lawrence and the tract of country on its right bank, where vines were found growing, unsown corn, and a tree called "Masur," these being regarded as *Vitis labrusca*, L., *Zizania aquatica*, L., and an Acer. The reasons why these voyages were not continued were explained as due to the weak colonies at that time in Greenland, the actual starting-point, and the opposition of the natives, termed "Skrællings," who prevented any attempts at settlements in "Vinland"—the Wineland of the sagas of Erik the Red and of Thorfinn Karlsefni—the northern part of New Brunswick.

Royal Meteorological Society, December 15.—Mr. R. H. Hooker, president, in the chair.—C. K. M. **Douglas**: Temperature variations in the lowest 4 km. The chief object of this paper is to emphasise the importance of the source of the air-supply in causing variations of the upper-air temperature, and to discuss the relationship of these variations to the weather changes, with special reference to the theories of Prof. V. Bjerknes, which the observations strongly support. The view put forward is certainly not disproved by statistical results, though the evidence for it is derived chiefly from the study of a large number of observations of temperature and humidity in the upper air, in conjunction with synoptic charts. Among the associated points mentioned in the paper the following may be emphasised: (1) Both troughs of low pressure and wedges of high pressure normally lie farther west in the upper air than at the surface. (2) The pressure in the upper air may be regarded as being partly a consequence, and not purely a cause, of the temperature of the underlying column. (3) Very powerful wind-currents are observed at great heights between the polar and the equatorial air at those levels.—A. P. **Wainwright**: A sunshine recorder (mechanical type). The new type of sunshine recorder is in the form of two mercury thermometers similar to one another and of fairly large capacity. The bulb of one thermometer, which is contained in a vacuum, is exposed to the direct rays of the sun, while the other is contained in the shade of a Stevenson screen. The difference in expansion of the mercury in each bulb is recorded mechanically by means of a pointer on a clockwork drum, and denotes the varying intensity of the sun's radiant heat at any hour of the day. The object of this instrument is to obtain a more detailed record of sunshine, and in particular to show the total intensity of the sun's rays for the day as apart from the number of hours during which the sun has actually put in an appearance.—Lt.-Col. J. E. E. **Craster**: An investigation of river-flow, rainfall, and evaporation records. Measurements of the flow of the Shannon show a fluctuation due to variations in the amount of rainfall and evaporation in the Shannon basin. Rainfall records for the Shannon basin are few, and there are no evaporation records, so that it is not possible at present to determine the amount of rainfall and evaporation by direct methods. But the monthly variations of the rainfall and evaporation, expressed as fractions of the total annual rainfall and evaporation, are constant over large areas. Records of evaporation from the soil have been kept at Rothamsted for many years, and in the absence of any Irish records it has been necessary to employ these. By using the monthly variations of rainfall and evaporation as described above it is possible to determine the minimum annual rainfall and evaporation in the Shannon basin, which will account for the fluctuations in the river flow. The minimum annual rainfall has been found to be 45·71 in., and the minimum annual evaporation from the soil 16·88 in.

MANCHESTER.

Literary and Philosophical Society, November 16.—Sir Henry A. Miers, president, in the chair.—A. E. **Heath**: The disinterested character of science in view of certain of its working maxims. The object of this paper was to show that Mach's "principle of economy" and Occam's "principle of parsimony" are not—as would appear on the surface—contradictory. It was contended that the sciences are synthetic, and consist in the setting up of conceptual constructions for the complete description of the fields of primary fact in each science. When alternative conceptual constructions are possible Mach's principle is used to decide between the alternatives. But the constant reference back to the field of primary fact removes from its use any menace to the disinterested character of science. Occam's principle, however, is a maxim applicable only to a process opposite in direction to the synthetic advance of the sciences, namely, the analysis of the field of primary fact itself. It is, therefore, not contradictory, but complementary, to the principle of economy.

Literary and Philosophical Society (Chemical Section), October 29.—Mr. J. H. Lester (chairman) in the chair.—J. H. **Lester**: Address on "The Textile Chemist." The value of a thorough training in physics was emphasised, and the importance of a post-graduate training in a technical college considered. The chemist in a dye-making works is only a textile chemist when he deals with the textile process of dyeing.

November 29.—Mr. J. H. Lester (chairman) in the chair.—H. E. **Potts**: How can the results of chemical research be best protected by patents? If the patent agent studied the subject sufficiently to criticise freely and intelligently the research programme, the requirements of the law could be met and the research at one and the same time assisted.

EDINBURGH.

Royal Society, December 6.—Prof. F. O. Bower, president, in the chair.—Miss A. **Mann**: Observations on the behaviour of the endodermis in the secondarily thickened root of *Dracaena fruticosa*, Koch. The paper demonstrated the effect of cambial activity in disintegrating the endodermis and establishing channels for direct ventilation between the cortex and the pith, which are otherwise isolated by the continuous endodermal sheath. Frequently where such a disintegration takes place the endodermis is not so easily recognised. Here it is a strongly indurated layer of cells, so that the detail of the disintegration can be accurately followed. The physiological result is that the large roots where secondary thickening occurs have a common ventilating system; but small roots, where the point is less vital, have the cortex strictly delimited by the endodermis from the central pith.—L. F. **Spath**: Cretaceous Ammonoidea from Angola collected by Prof. J. W. Gregory (with notes by the late G. C. Crick). These Ammonites formed part of a collection that included the Brachiopoda and Mollusca dealt with by R. B. Newton in a paper already published (Trans. R.S.E., vol. li.). The fauna was there described as belonging to the Vraconnian stage of the Cretaceous series, which includes the zone of *Schloenbachia inflata*. Since there is great confusion about this more or less universal "zone" and about the Ammonites found in it, an attempt had to be made to trace the interrelations of the numerous keeled Ammonites of the Gault and their ranges in time. Some new genera are proposed in addition to a classification of the Hoplitids in general, and a subdivision of the various horizons of the Upper Albian is offered. The specific descriptions deal with sixty different forms belonging to twelve genera. Some of these represent new, indeterminable, or doubtful species; but the genus to which *A. inflatus* itself belongs includes 50 per cent. of the total number of specimens. An analysis shows that half the number represent local types, some also occurring in the Albian of North Africa; but all the types common with Madagascar and India also occur in the European Gault—that is to say, what intermixture of Indian or American elements there is must have taken place *via* Thetys. The Ammonites do not include a single Cenomanian form. Some new facts of importance obtained from the study of various unworked collections in the British Museum from Angola, Nigeria, South and East Africa, and other localities are incorporated in this paper.

PARIS.

Academy of Sciences, November 29.—M. Henri Deslandres in the chair.—H. **Le Chatelier**: The phase rule. Some recent criticisms of the phase rule are based on misconceptions. A summary of Gibb's demonstration is given and some particular cases are examined in detail.—C. E. **Guillaume**: Cause of the instability of nickel-steels: its elimination (see p. 545).—C. **Sauvageau**: New observations on *Ectocarpus padinae*. The megaspores of this parasite on *Padina pavonia* can live and reproduce outside the plant acting as host; an alternation of generations between a summer parasitic plant and a winter plant of independent life is not improbable, although as yet unproved.—M. J. L. Breton was elected a free Academician in succession to the late M. Ad. Carnot.—R. **Birkeland**: The solution of the general equation of the fifth degree.—B. **Gambier**: The imaginary application of two real or imaginary surfaces. The corresponding real cyclic systems or triply orthogonal systems.—G. **Reboul**: A new property of substances feebly conducting electricity. If a photographic plate is covered with a sheet of black paper and placed in a dark box, and if two insulated electrodes with a potential difference of 1000 volts are brought into contact with the paper for a period of twenty-four to forty-eight hours, on developing the plate the fibres of the paper are found to be reproduced, and the equipotential lines also appear. If the paper is divided, or replaced by a sheet of metal or of mica, the effect is *nil* or confined to the electrodes. The effect can be modified by altering the conductivity of the sheet of paper.—S. **Procopiu**: The electrical dichroism of smoke and the dichroism of diffraction gratings.—S. **Posternak**: The constitution of the paramolybdates.—R. **Cornubert**: The spectrochemical study of the α-allyl and α-allylmethyl*cyclo*hexanones. The results are in agreement with the theory of Auwers on the influence of the double groups on the value of the molecular refraction.—C. **Dufraisse**: Remarks on the so-called dibenzoylmethane of J. Wislicenus. The author considers that the substance regarded by J. Wislicenus as dibenzoylmethane is, in reality, an ethylene oxide of the constitution

$$C_6H_5.CH-CH.CO.C_6H_5.$$
$$\diagdown O \diagup$$

—P. **Landrieu**: Researches on the acid and polyacid salts of monobasic acids: the potassium and lithium dibenzoates.—Mlle. Augusta **Hure**: The Lutecian limestone in the Yonne.—E. **Passemard**: The persistence of *Rhinoceros Mercki* in an Upper Mousterian deposit in the Basses-Pyrénées.—A. **Guilliermond**: New researches on the vacuole apparatus in plants. The vacuolar system in the embryonic cells of the higher plants frequently presents forms resembling mitochondria. These pseudo-mitochondrial forms do not show the histo-chemical characters of mitochondria, and should be definitely separated from the chondriome. The author considers the views of M. Dangeard with regard to the relation between these forms and the chondriome of the animal cell as erroneous.—L. **Daniel**: Researches on the grafting of Solanum.—L. **MacAuliffe** and A. **Marie**: The anthropometric study of 127 Spaniards.—M. **Baudouin**: The variations in the flattening of the tibia in infants and adults of the Neolithic races.—A. **Pézard**: Intrapuberal castration in cocks and the generalisation of the parabolic law of regression.—F. **Vlès** and J. **Bathellier**: The numerical laws of the pedal waves in the movements of Gasteropods.—P. **Wintrebert**: The comparative value and the determinism of the principal signs of aneural myotomic contraction observed in the embryos of *Scylliorhinus canicula*.—G. **Truffaut** and N. **Bezssonoff**: The characters common to the β bacterium, symbiotic with *Clostridium pastorianum* and *B. aliphaticum non liquefaciens*. The development of these two bacteria suggests that they belong to similar races, possibly to the same race.—G. **Odin**: A new method for the diagnosis of syphilis. Serum from the blood of the subject is mixed with physiological serum and a small proportion of sodium fluoride. The serum thus produced when injected into the patient increases all the syphilitic symptoms and makes a certain diagnosis. The method has been applied to more than a hundred cases without a single failure.

Books Received.

The Backward Peoples and our Relations with Them. By Sir Harry Johnston. (The World of To-day.) Pp. 64. (London: Oxford University Press,) 2s. 6d.

The Life of Horace Benedict de Saussure. By D. W. Freshfield. Pp. xii+479. (London: E. Arnold). 25s. net.

Home Mechanics Workshop Companion. By A. Jackson, jun. Pp. 222. (London: H. Frowde and Hodder and Stoughton.) 6s. net.

Home Soldering and Brazing. By R. F. Yates. Pp. 122. (London: H. Frowde and Hodder and Stoughton.) 4s. 6d. net.

Home Chemical Laboratory. By R. F. Yates. Pp. 127. (London: H. Frowde and Hodder and Stoughton.) 4s. 6d. net.

Soaring Flight: A Simple Mechanical Solution of the Problem. By Lt.-Col. R. de Villamil. Pp. 48. (London: C. Spon.) 1s. 6d. net.

Space and Time in Contemporary Physics. An Introduction to the Theory of Relativity and Gravitation. By Prof. M. Schlick. Translated by H. L. Brose. Pp. xi+89. (New York and London: Oxford University Press.) 6s. 6d. net.

The Geography of Plants. By Dr. M. E. Hardy. Pp. xii+327. (Oxford: Clarendon Press.) 7s. 6d. net.

Handbook of Spinning Tests for Cotton Growers. By Dr. W. L. Balls. Pp. 59. (London: Macmillan and Co., Ltd.) 3s. 6d. net.

Some Investigations in the Theory of Map Projections. By A. E. Young. Pp. viii+76. (London: Royal Geographical Society.) 6s. net.

Der Entropologische Gottesbeweis. By Dr. J. Schnippenkötter. Pp. 109. (Bonn: A. Marcus and E. Weber.) 15 marks.

Plane Algebraic Curves. By Prof. H. Hilton. Pp. xvi+388. (Oxford: Clarendon Press.) 28s. net.

Treatise on General and Industrial Organic

Chemistry. By Prof. E. Molinari. Translated from the third Italian edition by T. H. Pope. Part i. Pp. xv+456. (London: J. and A. Churchill.) 30s. net.

A Farmer's Handbook: A Manual for Students and Beginners. By R. C. Andrew. Pp. xvi+126+xliv plates. (London: G. Bell and Sons, Ltd.) 6s. net.

The World of Sound: Six Lectures delivered before a Juvenile Auditory at the Royal Institution, Christmas, 1919. By Sir W. Bragg. Pp. viii+196. (London: G. Bell and Sons, Ltd.) 6s. net.

Religion and the New Psychology: A Psycho-Analytic Study of Religion. By W. S. Swisher. Pp. xv+261. (London: G. Routledge and Sons, Ltd.) 10s. 6d. net.

Tables du Mouvement Képlérien. By Dr. M. F. Boquet. Première partie. Pp. vi+205. (Paris: A. Hermann et Fils.)

The Garden Doctor: Plants in Health and Disease. By F. J. Chittenden. Pp. x+154. (London: *Country Life*, Ltd.; New York: C. Scribner's Sons.) 7s. 6d. net.

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Properties of Steam and Thermodynamic Theory of Turbines. By Prof. H. L. Callendar. Pp. xi+531. (London: E. Arnold.) 40s. net.

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Application of Dyestuffs to Textiles, Paper, Leather, and other Materials. By Dr. J. M. Matthews. Pp. xvi+768. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 57s. 6d. net.

Zoomikrotechnik: Ein Wegweiser für Zoologen und Anatomen. By Prof. P. Mayer. Pp. vii+516. (Berlin: G. Borntraeger.) 64 marks.

Marine Engineering. By Engr.-Capt. A. E. Tompkins. Fifth edition, revised. Pp. xi+888. (London: Macmillan and Co., Ltd.) 36s. net.

Die Gestalten der normalen und abnormen Vogeleier analytisch bearbeitet. By Dr. A. Szielasko. Pp. v+119. (Berlin: W. Junk.)

Imperial Institute. Monographs on Mineral Resources, with Special Reference to the British Empire. Coal. By J. H. Ronaldson. Pp. ix+166. (London: J. Murray.) 6s. net.

Leicestershire. By G. N. Pingriff. Pp. xii+164. (Cambridge: At the University Press.) 4s. 6d. net.

Engineering for Land Drainage. By C. G. Elliott. Third edition, revised. Pp. xviii+363. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 13s. 6d. net.

A Text-book of Organic Chemistry. By Prof. A. F. Holleman. Edited by Dr. A. J. Walker. Fifth English edition, revised. Pp. xviii+642. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 18s. 6d. net.

Organic Medicinal Chemicals (Synthetic and Natural). By M. Barrowcliff and F. H. Carr. Pp. xiii+331. (London: Baillière, Tindall and Cox.) 15s. net.

Scurvy: Past and Present. By Prof. A. F. Hess. Pp. vii+279. (Philadelphia and London: J. B. Lippincott Co.) 18s. net.

Chemistry of Familiar Things. By S. S. Sadtler. Third edition, revised. Pp. xiii+322+xxiii plates. (Philadelphia and London: J. B. Lippincott Co.) 10s. 6d. net.

Laboratory Manual of Organic Chemistry. By Dr. H. L. Fisher. Pp. x+331. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 12s. 6d. net.

Agricultural Geology. By Dr. F. V. Emerson. Pp. xviii+319. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 16s. 6d. net.

Lippincott's Quick Reference Book for Medicine and Surgery. By Dr. G. E. Rehberger. (Philadelphia and London: J. B. Lippincott Co.) 63s. net.

Diary of Societies.

WEDNESDAY, DECEMBER 29.

ANNUAL CONFERENCE OF EDUCATIONAL ASSOCIATIONS (at Bedford College for Women), at 3.—Rt. Hon. H. A. L. Fisher: Instinct and Education.

THURSDAY, DECEMBER 30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. J. Arthur Thomson: The Haunts of Life: The School of the Shore (Juvenile Lectures).

ANNUAL CONFERENCE OF EDUCATIONAL ASSOCIATIONS (at University College, Gower Street), at 3.—Dr. A. F. Tredgold: Inheritance and Educability.—At 5.—Dr. L. R. Veitch Clark: Infant Mortality: Its Causes and Mitigation.

SATURDAY, JANUARY 1.

ANNUAL CONFERENCE OF EDUCATIONAL ASSOCIATIONS (at University College, Gower Street), at 10.30 a.m.—A Joint Conference on The Use of Psycho-analysis in Education.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. J. Arthur Thomson: The Haunts of Life: The Open Sea (Juvenile Lectures).

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—Lecture.

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NATURE

THURSDAY, DECEMBER 30, 1920.

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The Nile, Egypt, and the Sudan.

THE latest publication of the Public Works Ministry of Egypt is of more than usual interest, for it not only appears at a time when work is being resumed after being stopped, or at least largely restricted, during the war, but it also sets forth a large collection of data relating to projects which have met with criticism in some quarters during the last three years. A year ago the Nile Projects Commission was appointed to report upon the physical data upon which the engineering plans were based, and this Commission has now unanimously accepted Sir Murdoch MacDonald's evidence and approved his designs for the series of irrigation works described in the report before us.

A small amount of rain falls annually on the Mediterranean shore of Egypt, but this diminishes rapidly as we go southwards, so that it is of no value to agriculture, except for the winter crops raised by nomad tribes west of Alexandria. All the water that the increasingly intensive cultivation of Egypt demands must be supplied by the Nile, and recent surveys have established that there are about 7½ million acres which can be perennially cultivated if the necessary water is forthcoming at all seasons.

Fed by the summer rains on the Abyssinian tableland, the Nile begins to rise in Egypt in June, and reaches its maximum level in September, after which it falls slowly, the contribution of the White Nile delaying the reduction of the levels to a very appreciable extent. The task, therefore, of those in whose charge the control of the Nile water rests is to utilise the surplus water of the flood or of the river in the early stages of its fall in order to supplement the supply in the early summer, when the discharge is wholly inadequate to meet the demands of agriculture. From 1886, the earliest year for which statistics of the cultivated areas are available, there has been a steady increase in the area perennially cultivated, until now the area is greater by one-third, or more than a million feddans,[2] than it was in 1886 As some land is double-cropped, the total crop area now requiring water is somewhat more than 7½ million feddans.

While this rapid extension of the area under cultivation has been taking place, the population of Egypt has been increasing at a notable rate, and while it stood at 7½ millions in 1886, it numbered 12¾ millions in 1917; consequently, the cultivated area per head of population, which in 1886 was 0·65 feddan, in 1917 was 0·42 feddan, and the crop area had fallen from 0·89 feddan to 0·60 feddan. Thus one result of an improved administration of the country has been to increase the demands upon its irrigation in much the same proportion as new projects could be designed and carried out.

For the first decade after the reconquest of the Sudan in 1898 the lands bordering on the Nile and those areas where the summer rains made cultivation practicable sufficed for the support of the population which remained after fifteen years of Dervish rule. In 1903 experiments were made to test the feasibility of producing, with the aid of irrigation, crops suitable for export, such as wheat, sugar, and cotton; and the area which might be so cultivated in the Sudan was fixed at 10,000 feddans, an amount which was increased to 20,000 feddans when the Aswan Dam had been raised to its full height. It was now evident that the Sudan could in time utilise a much larger area of the fertile Gezira, the tract between the Blue and White Niles, if sufficient water could be taken from the Nile without prejudicing the supply required by Egypt; and the projects now described, which have been in preparation since before the war, have been designed to supply water for an area of 300,000 feddans in the Sudan, while safeguarding at the same time Egypt's requirements.

Accurate gauging of the volume discharged by the Nile at all stages was of the first importance,

[1] "Nile Control." By Sir Murdoch MacDonald, Adviser, Ministry of Public Works, Egypt. (Cairo: Government Press, 1920.) Price 20 P.T.

[2] A feddan is equivalent to 1·038 acres.

and much criticism has been directed against the tables of discharge which the Public Works Ministry has published; but there are no valid grounds whatever for doubting their correctness, and the accounts given of the rating of current-meters in this report, the accuracy of the discharges measured with them, and the method of measuring the volume discharged through the sluices of the Aswan Dam, show that the greatest care has been taken to obtain as high an accuracy as possible. The report of the Nile Projects Commission, which has just been issued, affords a complete vindication of the accuracy of these measurements.

In the early days of the British occupation of Egypt the reorganisation of the irrigation of the country was recognised as being of the first importance, and every improvement that was achieved produced large returns in the shape of increased economic prosperity. But as the margin of possible improvement grew narrower with each advance, greater precision of measurement became necessary, and for some years a special branch of the Public Works Ministry has been engaged upon the scientific investigation of all the problems of Nile hydrography. The necessity for this was clearly shown in the exceptionally low flood of 1913, and in the consequent deficiency in the supply in the following spring and summer. The volume discharged by the river in this exceptional year was only 41,000 million cubic metres, whereas the total requirements of Egypt and the Sudan by 1955 are estimated to reach 56,000 million, so that additional works must be constructed, even though such an extraordinarily low flood occurs but rarely. The Blue and White Niles, from which this additional supply must be obtained, differ fundamentally in their hydrographic character. The Blue Nile, with a comparatively short course of approximately 1500 kilometres and a fall of 1400 metres, carries a heavily silt-laden flood past Khartum which may reach and even exceed 9000 cubic metres a second. The White Nile, on the other hand, has deposited most of its load in the marsh region of its upper reaches, or on the plains of the Sobat River, so that its waters are clear and can be stored in a reservoir; also the shallow valley of the White Nile, with its exceedingly low slope, allows a very large volume to be held up by a work of moderate height.

The present scheme provides both for a dam across the White Nile valley at a short distance upstream of Khartoum, and for a dam on the Blue Nile near Sennar. The site selected for the White Nile dam is at Gebel Aulia, 45 kilometres upstream of Khartoum, where the valley is wide and shallow. A continuous masonry dam 5 kilometres long and further extended by 1½ kilometres of an earthen dam with a masonry core wall will hold up the waters of the White Nile to a height of 8 metres above summer river level, and to 9·5 metres in years of high flood; it will thus provide an additional 4000 million cubic metres of water for the development of Egyptian agriculture and for the reclamation of the northern shore of the Delta; it will also act as a protection work in high floods by holding up water until the crest of the Blue Nile flood has passed and the White Nile water can be released without danger. Evaporation over the surface of the reservoir which will be formed by the dam will be large, for the maximum area is 540 square kilometres, and observations show that it will amount to 11 mm. per day in April, and to 2·4 mm. in the rainy season when allowance has been made for the rainfall. The loss by absorption over the area of the reservoir must also be considerable, and 1 cubic metre of water per square metre of surface has been allowed for this.

For meeting the requirements of the Sudan, a dam is proposed on the Blue Nile near Sennar, and the one which has been designed will be a solid masonry structure of granite, with sluices and spillways sufficient to discharge 15,000 cubic metres per second. By the control which this dam will afford, such water as is needed for use in the Gezira can be withdrawn from the Blue Nile from July 15 to January 18, after which the reservoir upstream of the dam will supply the further requirements of the Sudan in order that the water flowing in the Blue Nile may pass on to Egypt without diminution.

The data relating to both these schemes are set out fully in the report, from which the amount of water which is required for the agricultural development of different regions at each season can be seen, and the provision for meeting these requirements by means of the storage and control provided by the dams at Aswan, Gebel Aulia, and Sennar can be readily examined.

Some subsidiary works will be needed, and one of these is a barrage at Naga Hamadi, in Upper Egypt. One effect of filling the new storage reservoir by means of the White Nile dam will be to lower slightly the maximum of the flood at Aswan, and, consequently, to make the watering of the higher lands of Upper Egypt more difficult. The conversion of land in this part of

Egypt from basin to the perennial system of irrigation is now due, and to meet these needs this barrage will have to be constructed.

Besides these works which are about to be constructed on the Blue and White Niles, two other projects of which the need in the future can be foreseen to complete the control of the Nile supply are briefly discussed. One of these is the Lake Albert dam, by means of which it is proposed to hold up a reserve store of water in the Albert Lake, which will be conveyed to the White Nile by a channel or channels so planned as to avoid the loss of water which now takes place in wide, shallow valleys where the sadd marshes are situated. The other scheme, which is even more briefly outlined, is the provision of a dam on the upper reaches of the Blue Nile to store 7000 million cubic metres of water, of which part would be kept as a permanent reserve in case of low floods, and the balance used to irrigate the cotton crop on one-third of a million feddan area in the Sudan. Nothing has yet been done on either of these projects, and no details are published in the report; they are only indicated as works which must eventually be undertaken to provide the necessary water for agriculture in arid and semi-arid areas of the Nile basin.

The report contains a large amount of valuable information on the utilisation of water under the special conditions which prevail in Egypt. The requirements of agriculture are fully stated by the responsible authorities of Egypt and the Sudan; detailed estimates of the amount of water which is available at various seasons are also given as the result of a long series of measurements which have been made in recent years. This collection of hydrographical data brings those which were previously available up to date, and supplements them by much information of greater accuracy on which the present projects have been based.

With a rapidly increasing population the occasional occurrence of such disastrously low floods as that of 1913 has carefully to be guarded against; on the other hand, the growing demands of cultivators in Egypt, and the needs of the Sudan, which will be increasing for years to come, call for the most careful investigation of the hydrography of the Nile, for, while the supply of water is shown to be sufficient to meet all anticipated requirements, this can be done only by a full control of the supply and a careful regulation at all seasons by suitable works.

Poynting's Scientific Papers.

Collected Scientific Papers. By Prof. J. H. Poynting. Pp. xxxii+768. (Cambridge: At the University Press, 1920.) Price 37*s.* 6*d.* net.

THESE papers make a stately volume of considerably more than 700 pages, and our thanks are due to the editors, Mr. Guy Barlow and Dr. Shakespear, for the ability with which they have performed their work, a work which, as old pupils of Poynting, must have been to them a labour of love. The volume contains an excellent portrait, and the type, paper, and binding are worthy of the Cambridge University Press. I think everyone, even though he may have thought himself well acquainted with Poynting's work, will find here something which he sees for the first time, for the volume includes not only papers from such normal sources as the Transactions and Proceedings of the Royal Society and the *Philosophical Magazine*, but also others from the *India Rubber Journal*, the *Hibbert Journal*, the "Encyclopædia of Biblical Literature," the *Mason College Magazine*, and the *Inquirer*. In addition to the classical papers on the flow of energy in the electromagnetic field, on the pressure of light, and on the density of the earth, there are others on the drunkenness statistics of the large towns, on the fluctuations in the price of wheat, on the experiences of one who overtook the waves of light, a criticism of Herbert Spencer's "First Principles," and a paper on physical law and life. To those who knew Poynting, these informal papers have a special charm, for they will find in them much that will recall memories of long-past talks; they recall his quiet humour, the freshness of his views, his courtesy in debate, his dread of saying or doing anything that could hurt the feelings of anyone who did not hold his own views on the point at issue. Among the seventy papers in this book, there are not more than two or three that could be called controversial, and it is characteristic of these that he criticises his opponent as if he loved him; and, even when the author under notice has laid himself more than usually open to criticism, Poynting is not content with pointing out the unsoundness of his statements; he suggests that he must really have meant something else, something much more reasonable.

Another feature of the book is that running throughout the papers is a view of the philosophy of physics which is now very prevalent, but which Poynting was one of the first in this country to adopt. This view is summarised in the paper on "Physical Law and Life"; and though this paper was not published until 1903, he had then held the views expressed in the following quotation for a long time:—

"I have no doubt whatever that our ultimate aim must be to describe the sensible in terms of the sensible. But I see, too, what gulfs there are still separating one part of our knowledge from another, and I see no harm in throwing temporary bridges of hypotheses across these detached gulfs to connect what would otherwise be detached regions. They allow us to pass to and fro with ease, and have been, and are, of enormous help to us in our exploration of Nature. But we must bear in mind that we may have many types of connecting bridge, many forms of hypothesis equally serviceable, all perhaps to be broken down and abandoned when we have filled in the gulfs which they crossed, and have made firm roadways built of sensible fact."

As another illustration of the modernness of his point of view, I may take a sentence from his address as president of Section A at the meeting of the British Association at Dover in 1899:—

"Another illustration of the illegitimate use of our hypothesis as it appears to me is the attempt to find in the ether a fixed datum for the measurement of material velocities and accelerations, a something in which we can draw our co-ordinate axes so that they will never turn or bend. . . . We could only fix positions and directions in the ether by buoying them with matter. We know nothing of the ether except by its effects on matter, and, after all, it would be the material buoys which would fix the position, and not the ether in which they float."

Poynting's scientific work concentrated in the main on three subjects: the flow of energy in the electromagnetic field, researches on gravity, and on the pressure of light. It is by the first of these that he is perhaps most widely known, and with which "Poynting's vector" will always associate his name. It was Poynting who introduced the idea that the energy in the electromagnetic field flows in the direction of a vector now known as "Poynting's vector," which is at right angles to both the electric and the magnetic forces, the rate of flow being proportional to the product of these two forces and the sine of the angle between them. Thus, whenever there are both electric and magnetic forces, there is flow of energy unless the two forces are in the same direction, and wherever there is flow of energy there are both electric and magnetic forces.

The importance we attach to this result will depend upon the view we take of the localisation and identification of energy. If we confine ourselves to the dynamics of a system of bodies acted upon by assigned forces, we may regard the kinetic and potential energies of the system as names for certain functions of the velocities and co-ordinates of the bodies which satisfy a sufficient number of equations to enable the co-ordinates of the system to be determined at any time if the co-ordinates and velocities at some previous time are known. The idea of localisation of energy is foreign to this point of view, for the amount of kinetic energy possessed by any member of the system will depend upon the choice of axes to which the velocities are referred, while when we regard the potential energy of two charges separated by a distance r as $-ee'/r$, the idea of localisation of energy is unmeaning and immaterial. When, however, we discard the idea of action at a distance, and regard the space between bodies as the seat of the influences they exert on each other, the question of the localisation of energy at once becomes prominent. Thus, to take a definite case, we may regard all energy as molecular in structure, and made up of a large number of units, all the units possessing the same amount of energy, and the energy of each unit remaining unchanged as the unit moves about. Thus the amount of energy in any region is proportional to the number of units of energy in that region, and changes in this amount are due to the motion into or out of this region of units of energy. From these points of view the motion of these units is what governs the behaviour of the system, and the flow of these units is represented by Poynting's vector. Poynting's work on the pressure of light and his determinations of the density of the earth by an ordinary balance are great tributes to his skill and insight as an experimenter. The method with the ordinary balance is, as he himself acknowledges, inferior to that employed by Boys, and yet Poynting was able to get, by care and skill, a result comparable in accuracy with that obtained by the better method.

Poynting's experimental skill and his power of devising simple apparatus which could be made in the laboratory and yet give results of the highest accuracy were quite remarkable, and the simplicity of the means by which he got his results was not surpassed either by Stokes or by the late Lord Rayleigh.

To read through everything that a man has published during forty years of scientific work, extending over a period remarkable for new discoveries and the introduction of new ideas, is a severe test for his reputation; it might be expected that much would seem musty and out of date; this, however, is not so with Poynting's papers, for in them there is little or nothing which in any way conflicts with modern ideas.

Poynting's researches, important as they are, form but a part of his life's work. He was a very successful teacher, and as professor of physics at Mason's College from its foundation he created and developed the flourishing school of physics at the University of Birmingham. He took his full share of the large amount of business and organisation required to carry on the work of his university and the scientific societies with which he was connected, and as a magistrate he took part in the civic life of Birmingham. Everyone who met him in these capacities found him the most delightful and courteous of colleagues, while to many he was the beloved and valued friend. J. J. THOMSON.

Scottish County Geographies.

(1) *Banff and District.* By Allan Edward Mahood. Edited by Dr. E. I. Spriggs. Pp. xvi+388. (Banff: *The Banffshire Journal*, Ltd., 1919.) Price 10*s.* 6*d.*

(2) *Orkney and Shetland.* By J. G. F. Moodie Heddle and T. Mainland. Pp. xii+167. (Cambridge: At the University Press, 1920.) Price 4*s.* 6*d.* net.

(3) *Caithness and Sutherland.* By H. F. Campbell. Pp. ix+168. (Cambridge: At the University Press, 1920.) Price 4*s.* 6*d.* net.

(4) *Kirkcudbrightshire and Wigtownshire.* By William Learmonth. Pp. ix+149. (Cambridge: At the University Press, 1920.) Price 4*s.* 6*d.* net.

(5) *Dumbartonshire.* By Dr. F. Mort. Pp. viii+155. (Cambridge: At the University Press, 1920.) Price 4*s.* 6*d.* net.

(1) DR. MAHOOD'S "Banff" belongs to the best class of local guide-book. It is the result of a careful study of the area by a number of enthusiastic students; the bulk of the material has been collected by Dr. Mahood, of Duff House Hospital. Chapters have been contributed by various local authorities, and the whole has been condensed and edited by Dr. E. I. Spriggs, and its stores of information are rendered accessible by an excellent index. The book is a compendium of the geography, history, and antiquities of the district, and should add greatly to the profitable enjoyment of a stay there by any intelligent visitor; and, as it gives practical guidance to the special points of interest, it should stimulate the study of the local archæology and natural history.

The walks around Banff are classified according to their length, and the programme of longer excursions refers to the numerous antiquities and to such features as the musical sands, the dunes of Culbin, and the remarkable southerly deflection of the plumb-line at Cowhythe, which would indicate a position nearly a fifth of a mile in error. Banff Museum is rich in local material, and the chapter on it is a useful introduction to the local archæology and history. Banff was the home of Thomas Edwards, the self-made naturalist with the Smiles-made reputation, who, amongst other contributions to science, demonstrated that the shell beds on the 25-ft. raised beach at Boyndie is a Neolithic kitchen-midden.

The geology of the area includes much of interest, and special attention has been recently directed to it by Mackie's discovery of the plant-bearing cherts of Rhynie, which have been proved by the researches of Kidston and Lang to be the oldest known land flora, and to contain, exquisitely preserved, the plants of the period when land was being first clothed with vegetation. The discovery of this flora is the most epoch-making in palæobotany in recent years. The account of the geology is well up to date; it recognises the Old Red Sandstone as a river-made deposit, but that view need not have been assigned to America, as it had been previously advanced in this country. A remark on the work of Prof. Jehu and D. Campbell on the Highland Border Series may be misunderstood as implying that some of the Highland schists have been thus proved to be Lower Palæozoic, whereas that work strongly strengthens the case for the pre-Palæozoic age of those schists.

(2–5) The volumes of the Cambridge University County Series suffer in contrast with that on Banff by the absence of references, as even a short bibliography would be of great assistance to the students for whom these admirable manuals would be of special service. Moreover, the one author deals with all branches of the subject—history, geography, archæology, ethnology, geology, natural history, and economics—and has to write on some questions with which he is not fully familiar. Consistency between the manuals and complete accuracy are possible only by editorial supervision. In this series the authors appear to be given entire independence provided they conform to the prescribed plan.

A student who turns to these volumes to compare the evidence on some question from different parts of Scotland finds puzzling inconsistencies. Thus the circular megalithic towers known as brochs, the most remarkable of Scottish antiquities, are attributed in the account of those in Caithness and Sutherland to the early Iron age, and therefore to be pre-Roman; whereas the volume on Orkney adopts the older and less probable theory that they were built as shelters against

Norse vikings, and would therefore be post-Roman. The advantage the volumes would gain from expert supervision may be illustrated by the sections on geology. Thus the Old Red Sandstone is still attributed in the volumes on Orkney and Shetland and on Caithness and Sutherland to lakes, whereas the work on Banff adopts the fluviatile explanation. The table of the geological succession in Caithness and Sutherland (pp. 13–15) states that the Upper Trias is absent from England, and that the Upper Cretaceous consists of "chalk and ware," whatever "ware" may be. The summary of the Carboniferous suggests an erroneous correlation of the English and Scottish divisions; the metamorphic rocks and schists are described as Silurian and Ordovician, and as younger than the Cambrian quartzites; while the discovery of Olonellus in beds above the Torridon Sandstone did not "fix the age of the Cambrian," but fixed those beds as Cambrian. The geological map of Kirkcudbrightshire and Wigtownshire omits the Permian of Loch Ryan, and marks the Permian Sandstones west of Dumfries as "blown sand and alluvium." The rainfall maps of Scotland in different volumes present marked differences in fact.

The four new volumes cover areas representative of the chief geographical types in Scotland—the highlands, the industrial localities of the Midland Valley, and the agricultural districts of the southern uplands—and the authors express clearly the characteristic features of the districts.

The Orkneys and Shetlands are the most exceptional area in the British Isles, which is differentiated by geographical structure, by the far northern position which led to the occasional visits of walrus until the destruction of the Spitsbergen herds, and by the Norse influence to which St. Magnus Cathedral is a striking witness. The population is pure Norse, except for the modern immigration of lowland Scots. The archipelagoes are graphically described by Messrs. Heddle and Mainland.

The recent story of Sutherland and Caithness is one of the saddest in the British Isles. Sutherland is the fifth in size of Scottish counties, and has the sparsest population of any British county. Its population reached its maximum in 1851, and that of Caithness continued to increase until 1861. There was a slight decline until 1871; then with the great extension of the deer forests followed swift and steady decline. Mr. Campbell describes Sutherland as "a desolate wilderness," and says that "one can behold in every direction miles upon miles of country destitute of any sign of human occupation." One result of the depopulation is the increasing difficulty in administration. The outlay on the roads, according to Mr. Campbell (p. 149), now amounts to an eighth of the total rental of the county. Roads suitable for local needs are quite unable to withstand motor traffic, and the upkeep of 500 miles of road at modern standards is beyond the local resources. The financial problems of the county are still unsolved.

The Galloway country, including Kirkcudbrightshire and Wigtownshire, the two southernmost counties in Scotland, presents problems of a different order. The one industry is farming, and mainly dairying; it is the home of the famous Galloway cattle. Farming has been greatly improved by co-operative systems, of which two local varieties are kaneing and bowing. In both the farmer provides land, stock, equipment, and fodder; labour is supplied by his associates, who take the produce and pay for the use of the cows, the kaner in cheese, and the bower in cash. The development of central butter and cream factories, which pay the farmers on the basis of the quantity of butter-fat in the milk supplied, is a more familiar co-operative method, and is proving very helpful.

The volume on Dumbartonshire, by Dr. F. Mort, is most attractively written, and especially good on the physical geography, although that subject is unusually difficult, as the county consists of three very dissimilar areas. It is part of the district known as "the Lennox," and it would have made a more natural geographical unit if it had been combined with Stirlingshire. The western part is an irregular strip of land running across the grain of the country, and its structure can be understood only by reference to the adjacent counties. The most important parts are that along the north bank of the Clyde from Loch Lomond to the western suburbs of Glasgow, and the detached eastern portion which extends south of the Kelvin further east than Stirling. It is owing to the industrial activity of these two areas that the population of the county, in spite of its sparseness in the rest, is fifty-seven times as dense as that of Sutherland, and has been growing at an accelerated rate from the decade when the Highland counties began their decline.

Dr. Mort discusses the proposed Forth-Clyde Ship Canal, and though the text refers to the Kelvin Valley route, which is that regarded with most favour in Glasgow, the only route marked on the sketch-map as for a ship canal is that through the Forth Valley. With present costs of labour and material, the estimate quoted would be quite inadequate, and a canal large enough to fulfil its proposed functions is probably at present financially impracticable. J. W. GREGORY.

Conifers.

Conifers and their Characteristics. By Charles Coltman-Rogers. Pp. xiii + 333. (London: John Murray, 1920.) Price 21*s*. net.

CONIFERS, like ferns, stove-plants, orchids, alpines, and the ignoble carpet-bedding, have had their high tide of popularity. The fashion for them owed its origin chiefly to the work of the collectors Jeffrey and William Lobb in western North America in the middle of last century, and to that of John Gould Veitch in Japan in the early "sixties." From these areas, especially the former, our gardens have obtained their noblest conifers. We are told that, from fifty to seventy years ago, so keen was the desire to plant them that many beautiful flowering trees were destroyed to provide the necessary space, and that gardens in general lost much of their brightness and seasonal charm by the displacement of deciduous trees in favour of the heavier, gloomy, unchanging conifers. Inevitably, the craze came to an end, for a good proportion of them were found to need particular conditions which many localities where they were planted did not provide; and there is no more distressing object in the garden than a sickly conifer. In course of time the pendulum swung so much in the opposite direction that conifers in recent years have been overmuch neglected.

To one who contemplates a serious and exhaustive study of the group, Mr. Coltman-Rogers's book cannot be regarded as anything more than a *hors d'œuvre*; but it is admirably adapted to stimulate a budding interest in these trees, and that probably was the author's chief aim. For this reason it would be scarcely fair to grumble at its shortcomings from the scientific point of view. At times Mr. Coltman-Rogers is apt to be discursive, not to say garrulous, but, on the whole, his gossip is pleasant and humorous, and his book will find many readers who would be repelled by a more technical work. It certainly contains much solid information, and the careful reader will find many curious and interesting peculiarities of the species pointed out which, unaided, he might very easily overlook. No detailed descriptions are given, but the last forty pages are devoted to a series of tables which contain a great deal of accurate information in condensed form; these will be a useful help in identifying species, and especially in differentiating those which are closely allied.

The book suffers from careless proof-reading, and the reader is apt to be irritated by the number of errors, trifling though they may be. On p. 97, for instance, the Douglas fir is said to have been discovered by Menzies in 1792 and introduced in 1828; and then overleaf the respective dates are given as 1791 and 1827. It was not necessary to repeat the information, but at least the two accounts should tally. Kaempferi is spelt "Kaemferi," which jars one with whom the golden larch is a favourite tree. The invariable use of capitals as the initial letter for specific names is contrary to accepted practice, but perhaps the author has his private reasons for this.

On the whole, the book is pleasant and instructive, admirably printed, and light to handle, and may be recommended to those who contemplate the planting or study of one of the noblest and most interesting groups of the world's trees.

Physiology for Students and Practitioners.

A Text-book of Physiology: For Students and Practitioners of Medicine. By Prof. Russell Burton-Opitz. Pp. 1185. (Philadelphia and London: W. B. Saunders Co., 1920.) Price 32*s*. 6*d*. net.

TO add to the already numerous text-books on physiology is presumably to have the conviction that one is supplying what is lacking in those already in existence. The striking thing about Prof. Burton-Opitz's "Physiology" is that its author makes no such claim. In the first edition of a new book a claim for being really up-to-date would perhaps have been its best for recognition at a time when even some of the better-known books are somewhat delinquent in this respect.

If the author aspires to anything, it is to brevity, although his book has some 1140 pages of text. His object has apparently been to collect all the classic facts and theories and put them into new words. In this he has succeeded admirably, and his book, on the whole, compares well with its rivals. On controversial subjects he states fairly the different aspects of the case, and no pains have been spared in collecting facts and ideas for which free acknowledgment is made of the obvious debt to other text-books. The book reviews the whole subject in the most comprehensive manner. The greatest zeal for the explanation of phenomena is shown; indeed, to the physiologist there is just a suspicion of unnecessary explanation; but, on the other hand, the giving of elementary facts renders the book all the more readable by students commencing the study of the subject or by practitioners who have forgotten such matters. Students, however, using the book in preparation for examination should be warned that principles are more important than data. The giving of references at the bottom of each page is excellent, but, although it is realised that a full bibliography is impossible, fuller references to the more recent work, especially in regard to the nervous system, would have been a distinct advantage.

The logical way in which the facts are put forward, the short allusions to the history of the subject and to comparative physiology, together with a freedom from any attempt to compile a book for examination purposes, will recommend it to the purely scientific worker.

Generally, the book is well written and produced, but the language, which contains many Americanisms, leaves no doubt as to its nationality, and does not enhance its literary value. The author does not acknowledge any help in the preparation of the volume, which must have entailed an enormous amount of work. We congratulate Prof. Burton-Opitz on its completion, and wish his excellent and ambitious text-book every success.

Our Bookshelf.

The Planting, Cultivation, and Expression of Coconuts, Kernels, Cacao, and Edible Vegetable Oils and Seeds of Commerce. A Practical Handbook for Planters, Financiers, Scientists, and Others. By H. Osman Newland. (Griffin's Technological Handbooks.) Pp. vi + 111 + xi plates. (London: Charles Griffin and Co., Ltd., 1919.) Price 6*s*. net.

Mr. Newland scarcely gave himself a fair chance when, to quote his introduction, he was "prevailed upon to issue as a separate book the chapters on 'Ground Nuts,' 'Palm Oil and Kernels,' 'Cacao,' and 'Shea Nuts,' which originally formed part of a volume on *West Africa*." In doing this he has added chapters on coconuts and other edible oil-nuts found throughout the Empire, and has adopted for the whole a comprehensive title, the promise of which it would require unusual skill in compression to fulfil in a book of 111 not very closely printed pages. Moreover, the space at the author's disposal is not well distributed; thus the important oil-seeds soya bean, cotton-seed, and sesame are disposed of in one chapter of seven pages, whilst an equal number of pages are given to reprinting Imperial Institute reports on strephonema, n'gore, n'kamba, n'kula, kamoot, and dika nuts. Interesting though these products may be, they are not of commercial importance at present, and reference to them is out of place in a book of this description. The illustrations are the best feature of the volume. T. A. H.

The Flora of Chepstow. By W. A. Shoolbred. Pp. x + 140. (London: Taylor and Francis, 1920.) Price 10*s*. 6*d*. net.

In number and quality the local Floras of this country probably excel those of any other, and afford a satisfactory measure of the enthusiasm with which systematic botany is pursued by British naturalists, including a large number of amateurs who are wholly free from any stigma of superficiality.

Indeed, the greatest authorities on the species of the British flora are nearly all amateurs, very few professional botanists, outside the great museums, having either the time or the inclination to devote themselves to this specialist study.

Among these authorities Dr. Shoolbred holds a place, and his "Flora of Chepstow" is a praiseworthy addition to floristic literature. The area of the lower Wye has long been a favourite hunting-ground among botanists, for its position and topography give it an uncommon richness.

While the author takes a thoroughly exclusive view of the size of species, still, a list of 974 Angiosperms alone is pretty good for an area of, roughly, 65 square miles, now seriously threatened by industrialism.

The critical genera are fully treated, and Dr. Shoolbred has had the advantage of assistance from such men as Marshall and Ley in dealing with their many difficulties. Mosses are also included, a feature worthy of further resuscitation.

Electricity and Magnetism: Theoretical and Practical. By Dr. C. E. Ashford. Third edition. Pp. xii + 303. (London: Edward Arnold, 1920.) Price 4*s*. 6*d*.

The chapter on Röntgen rays which has formed a part of previous editions of this school text-book has been replaced in the present edition by one on the passage of electricity through gases. In this some account is given of the broad generalisations which have followed from the work of Sir J. J. Thomson and his school, and the application of these theories in the thermionic valve. A few articles have been rewritten, and an appendix on Ohm's law has been substituted for the original description of apparatus. The popularity and worth of this book are reflected in the fact that it has been through the printers' hands no fewer than thirteen times since the first edition was published in 1903, and during that period has been twice revised to meet new requirements of theory and practice.

A Text-book of Geology. By Philip Lake and R. H. Rastall. Third edition. Pp. xiv + 508 + xxxiii plates. (London: Edward Arnold, 1920.) Price 21*s*. net.

A complete revision of this standard work has been carried out since the first edition was reviewed in Nature for June 22, 1911. The account of coral reefs has been modified in accordance with modern theories, the chapter on ore-deposits has been rewritten, and sections on concretions, petroleum, and natural gas have been added to that on sedimentary rocks. In the stratigraphical section of the book the account of the Carboniferous system has been largely rewritten, and Mr. Rastall has contributed a new chapter on the history of igneous activity in the British Isles. Numerous other minor alterations have also been made.

Recent Advances in Organic Chemistry. By Prof. A. W. Stewart. With an introduction by Prof. J. N. Collie. Fourth edition. Pp. xvi+359. (London: Longmans, Green, and Co., 1920.) Price 21s. net.

ALTHOUGH the previous edition of this book was reviewed in NATURE so recently as in the issue for February 20, 1919, Prof. Stewart has written one new chapter, and made several additions to those already existing. The former directs attention to some of the problems which are still open to solution, such as the reason why carbon among all the elements is pre-eminent in its capacity for forming long atomic chains; the addition reactions of the aldehydes; molecular stability, etc. The chapter on polypeptides has received the addition of a section which attempts to trace in outline the connection between the synthetic materials and the naturally occurring proteins and their derivatives. A number of sections have also been added to various chapters with the object of bringing the book up to date.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The British Association.

LIKE Prof. Armstrong, I have followed with much interest the discussion about the British Association. I have had a long and intimate acquaintance with it, and have a strong affection for it. For one thing, it is so truly British—so far from perfect, yet so adaptable. I am not sure that my most earnest prayer for it is not that it may be saved from the reformer, especially the type of post-war reformer who threatens to organise, systematise, advertise, and Teutonise every British institution on which he can lay hands. It is surprising that no one has suggested the Association should be put under the Department of Scientific and Industrial Research.

I have heard the British Association abused all my life; my own Section has always been the worst that ever was and hopelessly mismanaged, except in the year when I was its president—at least, so I have always been assured. But all the time the British Association has been bringing me—a rustic—into the possession of troops of friends in all quarters of this country and of foreign lands. I have gained more scientific help from it than I can well acknowledge, and I am sure a vast number of my contemporaries will say the same.

As to the intelligent public, I doubt whether the Association ever did so much as some people affirm. It does a little, if only in letting a hospitable *bourgeoisie* see that men of science are well-meaning human beings, more like themselves than you would have supposed. At one period the Association fluttered the theological dovecotes and gave excellent copy for the Press. There has scarcely been a year in my time when the newspapers have not remarked ruefully that the president's address lacked the interest of Tyndall's at Belfast. It is not easy to see how the Association can give scientific enlightenment to those who have not even the elements of scientific knowledge. In these days it can scarcely hope to appeal to the Press except by its indiscretions.

I should be sorry to be open to any just taunt of unprogressiveness, and, indeed, I have read carefully and reflected upon all that has been said by your correspondents. But it is difficult to discern agreement on any clear and practicable plan of reform. The British Association is an organism, not a machine. It seems to me to have grown, and grown well—not overgrown. I would say: "Let it grow, my friends; most of you have had fair fruit from it. Let us be chary of root-and-branch reform." The Association is very flexible; a great deal must depend on the personalities of the men in charge. To be a local secretary at the elbow of the late Mr. George Griffith when he was arranging a meeting and managing his superior officers was a memorable and impressive experience. Everyone will be able to recall a run of success in a Section when an exceptional man had a spell of office as recorder. I am sanguine enough to believe that exceptional men, capable and disinterested, will still be found; and that if, as I am not prepared to admit, we are unfortunate at present, we may safely count on recovery.

Lastly, as to the masses, it should be remembered that science is not the novelty it was. It is astonishing how many of them have seen phosphorus burn in oxygen. Anyone who has been in the trade knows that the old type of science lecture for the people, when a serious effort was made to illustrate the methods and topics of science, is a drug on the market. You find yourself as powder among the jam of overt or covert entertainers. In this direction let us hope the Workers' Educational Association may bring about results that can never be attained by isolated popular lectures during a British Association week.

I trust that nothing in the foregoing may appear disrespectful to those who have expressed opinions on the same subject. It is, no doubt, of great value to have comments and suggestions from such competent observers. I have only intervened because it seemed to me that bare justice has scarcely been done to what is undoubtedly good and great in the Association as it stands, and to the ruling powers who have an exceedingly difficult task to perform.

ARTHUR SMITHELLS.

December 19.

Science and Fisheries.

No one will gainsay Mr. H. G. Maurice's fundamental premise (NATURE, November 25, p. 419) that scientific fisheries investigation is primarily a matter for the State—if the authorities have a due sense of their responsibility in selecting for the task scientific men whose training and ability specially fit them for the complex work. It has long been advised that the three centres of the kingdom should have an adequate scientific fisheries staff, at the head of which a trained scientific expert of wide views should be placed.

Under Mr. Maurice's second head it is asserted that statistics could not be secured, say by the Marine Biological Association at Grimsby or at any other port; but whilst there is no doubt that the best channel for these, as in the case of the Fishery Board for Scotland, is the fishery officers of the Government, Mr. Holt's work alone at Grimsby shows that the statement needs qualification. The excellent method of the Scottish Board, which was in 1884 inaugurated by Lord Dalhousie, should be followed. It would also be well that returns by all fishing crews should be sent to the central office through the same agents, as was recommended in the scientific Report on Trawling in 1884. Mere enumeration of the sizes of fishes on board the ships, however, is insufficient. The observers should take in the whole surroundings of the products of the areas so as to be able to contrast them with others. It is also uncertain if the proposed comparison of the yield of the North Sea with pre-war days will result in any trustworthy information. Nature is superior to any influences on that head, Dutch statements notwithstanding. Again, the fact that much of the supply of fish-food for the public of this country comes from extra-territorial waters should not be held as a reason for international co-operation in fishery researches. Friendly co-operation between Governments is right, but it does not seem to be necessary in scientific fisheries researches. Britain did not attain her pre-eminence in the sea-fisheries by international aid, nor will international co-operation help her to maintain that position. The work of the Dutch alone is a sufficient criticism on the supposed necessity for international co-operation.

Mr. Maurice thinks that science has not yet proved the ineffectual and unnecessary nature of the closure of areas of the open seaboard, such as the Moray Firth. He has still to study the work of the *Garland* and other ships, as well as various experiences since Lord Dalhousie's Commission. Instead of the view of the futility of one nation working alone at scientific fisheries work, it may be that this is just where progress can best be made; and, besides, fisheries publications rapidly spread information over the world. Moreover, fisheries investigations are best carried out at marine laboratories in the midst of fishing-boats and in touch with the sea. That Great Britain continued to subsidise the international scheme during the war is, perhaps, of less moment than it appears when the results (chiefly statistics of fishes collected at ports, compiled by subordinates, and treated by the chiefs on land) are duly weighed.

There is little fear of the serious depletion of the stock of fishes in the ocean, and less of man successfully adding to it. Again, little is to be gained by a fortuitous prophecy as to good or bad seasons. The fishes are there to be captured in their seasons, though there is still much to be learned about them in marine laboratories and on board fishing vessels. There are not a few points for investigation, for instance, to be found in criticisms of the International Council at its inception (1902–3). A perusal of the British fisheries from early times may also be suggestive.

Mr. Maurice is to be commended for his friendly view of independent fisheries research and of giving a wide margin to Departmental work. If the Secretary for Scotland in 1896 had embraced similar broad views, one laboratory at least where the pioneer scientific fisheries researches of this country were done would not have been closed to-day and the supply of trained young men for the Department cut off. Mr. Maurice's closing words are excellent, only a Council for the National Exploration of the Sea should be substituted for the International Council.

W. C. McIntosh.

I thank you for the opportunity afforded me of commenting on Prof. McIntosh's letter, and him for his friendly criticism. I may, perhaps, be permitted, without discussing all his points in detail, to develop somewhat my views regarding international co-operation in scientific research, which Prof. McIntosh has not, I think, quite understood.

I cordially endorse the statement that "Britain did not attain her pre-eminence in the sea-fisheries by international aid, nor will international co-operation help her to maintain that position." Britain will maintain her pre-eminence, I think, in the future, as in the past, by the enterprise of her fishermen and fishing-vessel owners. But their enterprise is directed solely to the catching and marketing of fish. The practical object of research, as I conceive it, is mainly conservation and development. I think we must admit that, under existing conditions, there is a real danger of the depletion of the fishing-grounds up to the point at which fishing will be unremunerative, with all the undesirable results which must follow from that state of things. Whether we seek to forestall the danger by mere restriction of fishing operations, or by measures of development, or by a combination of the two, what we shall in fact be aiming at is the practical application of the results of scientific work on fishing-grounds which are open to all nations. No such measures as are here suggested can be effective unless they have the support of all the nations which have access to fishing-grounds. Such support is most likely to be accorded as a result of partnership in investigations and of agreement as to the conclusions to be drawn from them. The International Council does not claim to be above criticism, but if the necessity for international co-operation be admitted, it is entitled to support until a more effective organisation for combined research can be substituted for it.

That is one aspect of the matter, but there is another. As a layman I am greatly impressed with the vastness and the complexity of the problems of the sea. In order to solve them it does not seem to me to be sufficient that the different nations should be working independently at scientific fisheries work. Where so wide a field is to be covered, co-ordinated effort in a concerted programme must surely be of unusual value; in some inquiries simultaneity of observations is, I understand, of great importance. "The view of the futility of one nation working alone at scientific fisheries work" is not one that I have expressed; and if I believed that there was a serious risk of national work being subordinated to the requirements of international agreement, I would not urge international co-operation. I do, however, hold strongly that the value of much of the work of each nation depends upon its co-ordination with the work of others and upon the fact that it is part of an intelligently concerted programme of joint investigations. Whether as an outcome of our investigations we shall eventually be able, not merely to conserve fisheries, but even to develop them, remains to be proved. I will not embark upon prophecy, but I know that some of my scientific friends believe that this end will eventually be reached.

In his opening paragraph Prof. McIntosh refers to the proposal to form a central scientific fisheries staff for the United Kingdom. He will be interested to learn that an arrangement has now for some time been in operation under which the staffs of the Scottish Fishery Board, the Irish Department, and the Fisheries Department of the Ministry of Agriculture and Fisheries meet at regular intervals to frame their scientific programmes and to report progress, and that these meetings are generally attended, to the great advantage of the work, by a certain number of the distinguished men of science attached to our chief marine biological stations.

I am not sure whether I am to understand that Prof. McIntosh holds that science has proved closure of areas of the open seaboard to be ineffectual and unnecessary. I have not consciously expressed an opinion upon this subject, because, as a layman, I am unwilling to rush in where even a scientific angel may be disposed to tread delicately. As a Government official I am discreet enough not to venture on a public discussion of the merits of so controversial a topic as the closure of the Moray Firth.

December 21. HENRY G. MAURICE.

Propagation of a Finite Number of Waves.

IT has been stated as a general proposition by physicists that it is impossible to propagate a finite number of simple harmonic waves without change of type, the reason being that the discontinuity of motion at the beginning and end of the train of waves cannot be represented by a simple sine or cosine function.

The proposition as stated is too general, and should be qualified. It would be true, however, to say that a finite number of simple harmonic waves cannot be propagated without change of type if the mean pressures in the wave-train and in the undisturbed medium are the same.

That a finite train of waves of unchanging type can actually be propagated in a medium in which the wave-velocity and group-velocity are the same may be seen from the following illustration:

Let the medium be enclosed in an indefinitely long pipe containing a piston on which a simple harmonic motion of amplitude a may be imposed. Let the medium and piston be at rest when the latter is in one of the *extreme positions*. If the motion is then started there is no discontinuity either in the velocity or in the acceleration. So long as the motion of the piston is maintained, simple harmonic waves are propagated through the tube in both directions, the mean pressure in one set being $p_0(1+a/\lambda)$ and in the other $p_0(1-a/\lambda)$, where p_0 is the undisturbed pressure.

At the moment when the motion is started the pressure on both sides of the piston is p_0, and this is the maximum or minimum pressure in each wave series, according as the direction of motion of the piston tends to dilate the medium or to compress it. The necessary increase and decrease of mean pressure in the two wave series are automatically supplied by the work done by the exterior force which must be applied to the piston to generate the successive waves. If the motion is stopped where the piston is in the same extreme position in which it was started, a finite number of simple harmonic waves are left travelling along the tube in opposite directions.

A. MALLOCK.

Solar Variation and the Weather.

MR. CLAYTON's representation in NATURE of December 9 that, apart from seasonal and diurnal changes, the "chief, if not the only," cause of weather change lies in solar variations overlooks an important source of variation in the atmosphere which could not be allowed for on the lines of his investigation. No one will dispute that if Mr. Clayton finally substantiates his correlation results, which have been severely criticised in America by Dr. C. F. Marvin (*Monthly Weather Review*, March, 1920) they will be of great value in forecasting deviations from the normal of particular elements, such as temperature and rainfall, in coming seasons. But they will not help us to foresee the actual *sequence* of atmospheric phases embodying the combination of all elements which we call weather; and it is the precise sequence of changes, not the departure of one or more elements from normal during a given period, which, after all, is the primary aim in weather forecasting.

It seems almost certain that however closely types may recur, the atmosphere is never twice in the same condition, and this, I believe, is a prominent conviction in the minds of those meteorologists with a lengthy experience of daily weather maps. If a series of phases in the circulation of the atmosphere be represented by $A_1 B_1 C_1 D_1$ . . ., it is conceivable that by an odd chance there might be a recurrence some time later of the particular phase A_2; but unless, which seems almost infinitely improbable, all the external forces acting upon the atmosphere at the moment A_2 are identical with those which were in operation at the moment A_1, there will be no cyclic repetition $A_2 B_2 C_2 D_2$ . . . to be maintained for a longer or shorter period. In place of the repeating cycle a very different series of phases might emerge; and it is on this principle that no two seasons are ever alike in the actual sequence of phases.

In other words, once set a fluid system like the earth's atmosphere in motion and change, it will possess an internal source of variability because identical dispositions of external forces never act upon identical phases. No doubt, with a sufficient number and quality of simultaneous observations, meteorologists could so diagnose the condition of the atmosphere as to be able to calculate what phase would grow out of a present phase a few hours later; but the prevision of distant phases, which is really at the root of the weather problem, seems at present quite impossible.

L. C. W. BONACINA.

27 Tanza Road, Hampstead, N.W.3, December 19.

Name for the Positive Nucleus.

WHILE the word "hydrion" does strictly express the meaning conveyed by the symbol H+, yet in the minds of chemists it connotes all those properties associated with its hampered state in solutions, especially aqueous solutions. Even if hydrion is not hydrated like other ions, yet there is probably some sort of electrical double layer which modifies its properties. The "wet" physical chemist might abandon his term "hydrion" and the symbol, recognising that the real hydrion (H+) will have entirely different properties if ever these are known. He is in possession, however, and is not likely to do this unless, perhaps, some variant term, such as "hydro-ion," might be found acceptable. The alternative symbol H is, of course, already to hand, and, indeed, more widely used than H+, which could be left to the physicists.

In spite of these minor difficulties, it appears to me that Prof. Soddy's suggestion (NATURE, December 16, p. 502) should be acceptable to chemists, largely because it is provisional in character and avoids the multiplication of words and symbols. Although it expresses a view as to the ultimate constitution of matter which may not prove correct, yet it is only the existence of such a view which necessitates a word and a symbol. If the other words suggested are to be taken as entirely non-committal, then the choice of one is less important at present, and, if effected, the word will probably soon acquire different meanings when used by different schools of thought.

E. B. R. PRIDEAUX.

University College, Nottingham, December 18.

The Physical Meaning of Spherical Aberration.

MAY I correct an obvious mistake of mine which I notice in my letter on spherical aberration appearing in NATURE of December 9? The second expression for intensity should read:

$$I = \text{const} \times \left[\left\{ \int_{a=0}^{a=a_1} J_0(\alpha a) \cos \eta_a \, d(a^2) \right\}^2 + \left\{ \int_{a=0}^{a=a_1} J_0(\alpha a) \sin \eta_a \, d(a^2) \right\}^2 \right].$$

L. C. MARTIN.

Imperial College, S.W.7, December 17.

Man and the Scottish Fauna.[1]

IN undertaking an estimate of the manner and degree in which the fauna of Scotland has been affected and modified in consequence of human occupation, Dr. Ritchie has brought together a very large array of facts, and, on the whole, he is laudably cautious in deduction therefrom. He begins by an attempt to visualise what is now Scotland as it was when man first settled there. Here is plenty of room for speculation, and we cannot but think that some lines in the sketch are drawn more firmly than is warranted by the evidence.

The earliest traces of the primitive peoples in Scotland are associated with the so-called fifty-foot beach. Their canoes, simple dug-outs of pine, have been found at Perth in the Carse clays of this period, and frequently in similar deposits in the Forth and Clyde valleys (p. 9).

Among the very numerous canoes exhumed in Scotland during the nineteenth century (seventeen dug-outs have been recorded from the Clyde valley alone), not one has consisted of any material but oak, the only native timber that remains sound for an indefinite period; but, accepting "pine" as *lapsus calami* for "oak," is Dr. Ritchie justified in assuming such a high antiquity for these canoes? Passing on to p. 20, we get a glimpse of a landscape scarcely likely to produce either oak or pine big enough for a dug-out.

Partial and incomplete as our survey of early Scotland must be, it yet affords a reasonably accurate picture of the country when Neolithic man . . . founded his most northern settlements in the British Isles 9000 or more years ago. It was a country of swamps, low forests of birch, alder and willow, fertile meadows and snow-capped mountains.

A difficulty arises in the stress laid by the author on the 50-ft. beach as the cradle of the human race in Scotland. He never mentions the 25-ft. beach which, being thousands of years younger than the other, is far better defined and more extensively preserved, especially on the west coast. Take, for example, the shores of the Bay of Luce; while the 50-ft. beach can only be traced here and there in fragments, the 25-ft. beach runs unbroken for miles, forming the terminal moraine of the land ice, without any margin between its ancient high-water mark and the base of the ground moraine—a mantle of boulder clay in places 100 ft. thick. The difficulty consists in accounting for the existence of men, or at least for the preservation of their traces, in the older 50-ft. beach; whereas it is clear that the land ice was grinding over all after the elevation which formed the younger 25-ft. beach.

Passing to later times, Dr. Ritchie takes us on firmer ground, and will meet with no dissent from his proposition that the main factor in the extinction of some indigenous mammals and birds was the destruction of the primeval forest, the woodland which survived longest being consumed as fuel for iron-smelting in the eighteenth century. The squirrel has found its way back as plantations increased; so have the great spotted woodpecker and the jay; while the capercailzie, which became extinct towards the close of the eighteenth century, was successfully re-established at Taymouth in 1837–38, and now abounds in several counties. We still await the return of the beautiful green woodpecker (not mentioned by Dr. Ritchie), which Thomas the Rhymer listened to long ago on Tweedside.

FIG. 1.—Soay sheep—a primitive domesticated breed preserved only in Scotland. From "The influence of Man on Animal Life in Scotland."

> In a mery mornynge of Maye,
> By Huntle bankkes myself allone,
> I herde the jay and the throstle cokke,
> The mawys menyde hir of hir song,
> The *wodewale* beryde as a belle,
> That all the wode abowte me ronge.

While game-preserving is responsible for the disappearance of the polecat and the goshawk, our loss of the osprey and the erne must be laid to the account of egg-collectors. On the other hand, Dr. Ritchie enumerates many species of beast and bird that have increased with the ad-

[1] "The Influence of Man on Animal Life in Scotland: A Study in Faunal Evolution." By Dr. James Ritchie. Pp. xvi+550. (Cambridge: At the University Press, 1920.) Price 28s. net.

vance of agriculture—moles, for instance, and field voles, besides both insectivorous and grain-eating birds.

The author follows the late Dr. Günther in giving specific rank to what are now recognised as no more than local varieties of the brown trout

FIG. 2.—Cheviot sheep—a modern result of selective breeding (champion, Highland Show, 1914.) From "The Influence of Man on Animal Life in Scotland."

—*Salmo fario* (misnamed *S. trutta* on p. 278). The signal success which rewarded the acclimatisation of this fish in New Zealand was first achieved with trout, not from Lochleven, but from the Wooburn at High Wycombe. A few slips and misprints await correction in a future edition. Loch Askaig (p. 134) should be Loch Arkaig; Loch-an-Eilein on the same page appears as Loch-an-Eilan on p. 192, the correct Gaelic being Loch-an-eilain. Dr. Ritchie would probably wince if we were to write about "Northumberlandshire," just as we did when we read "Sutherlandshire" on p. 126.

Few of the numerous illustrations are worthy of Dr. Ritchie's interesting treatise. The beaver (Fig. 37) and the bittern (Fig. 64) are mere caricatures, and poor at that. Some of the figures, however, serve well to illustrate the influence of domestication and selective breeding upon primitive types of mammal, as in the case of the sheep. Although it may not be possible to define with precision the various species which have contributed to produce the modern breeds, sheep, though a race almost exclusively Palæarctic and Nearctic, are peculiarly liable to modification by food and environment, and are more plastic in that respect than cattle, horses, or swine.

While indicating some hesitation in accepting all Dr. Ritchie's conclusions, we congratulate him on his useful contribution to zoological literature, and we are grateful for the excellent index to the book.

Some Problems of Lubrication.[1]

By W. B. HARDY, F.R.S.

IN lubrication, a fluid or other body is used to decrease the friction between opposed solid faces. The lubricant may act in one of two ways. It may separate the faces by a layer thick enough to substitute its own internal friction, modified by the mechanical conditions in which it finds itself, for that of the solid faces; or it may be present as a film, too thin to develop its properties when in mass, which reacts with the substance of the solid faces to confer upon them new physical properties. In the latter case the solid faces continue to influence each other, not directly, but through the intermediation of the film of lubricant. There are indications that these two types of lubrication—one in which the solid faces intervene only owing to their form, rate of movement, etc., and not by their chemical constitution; the other in which the chemical constitution is directly involved—are discontinuous states in that one cannot be changed gradually into the other by simply thinning the layer of lubricant. The change from the one to the other is probably abrupt.

It may by no means be asserted that resistance to relative motion is always least when the solid faces are floated completely apart; it would, indeed, probably be truer to say of the best lubricants that friction is least when the "boundary conditions," to use Osborne Reynolds's phrase, are fully operative.

This address is concerned wholly with "boundary conditions," and we get directly to the heart of the problem by certain simple experiments. If a glass vessel, such as a bottle, is placed upon an inclined pane of glass at a certain angle it slips smoothly down. The glass plate is an ordinary plate cleaned with a cloth. In the usual sense of the word, the plate is not lubricated; the surface is "dry." The lower half of the plate is then wetted with water, and the bottle is now found to slip on the unwetted part, and to be pulled up sharply by friction when

[1] A Friday evening discourse delivered at the Royal Institution on February 27, 1920.

it reaches the wetted part. It is not sufficient, therefore, to interpose a liquid film between solid faces to get lubrication; indeed, as the experiment proves, water increases the friction; it is an anti-lubricant for ordinary faces of glass.

Is, then, the quality of lubricant a property of a fluid? Does water fail to act merely because it does not possess that property to which the name "oiliness" is sometimes given? Another simple experiment supplies the answer. Instead of a glass plate, let us use a plate of ebonite. The glass plate does not readily slip on this. The angle at which slipping occurs is steeper than when a glass plate is used. Now, when the lower half of the ebonite plate is wetted, it is found that a glass bottle encounters relatively high friction on the unwetted part, but slips quite freely on the wetted part. Water, in short, is an admirable lubricant for glass on ebonite. Here is another plate, picked up at random in the laboratory of the Royal Institution. Its composition is unknown. Tested in the same way, water has no detectable influence on the friction between glass and the surface of this plate.

It will be well to confess at once that these simple experiments raise questions which are as yet without an answer, and that much of what follows concerning them is merely tentative. They seem to establish two things, the first being the curious paradox that a film of fluid introduced between two surfaces does not always decrease friction—it may, indeed, very much increase it. The second is that the quality of "oiliness"—the quality, that is, which enables a substance to act as a lubricant—seems to be not the property of a given fluid, but only of that fluid considered in reference to a particular surface.

It is necessary at this stage to clear away a possible explanation of the paradox. When two solid faces are separated by a thin film of fluid, capillary forces operate, and, in certain cases at any rate, these forces act so as to resist slipping. They will so act, for instance, when the movement of one face past the other increases the area of the free surface of the film. Water has a high surface-tension; the capillary forces to which it gives rise are usually large; therefore it is pertinent to ask whether, when a layer of water diminishes the facility for the slipping of glass on glass, it is owing to capillary action. A qualitative answer is to be found in the fact that water does in some cases, as when glass is applied to ebonite, increase the facility for slipping; and the late Lord Rayleigh furnished the quantitative answer. He calculated the magnitude of the capillary effect and found it negligible compared with the actual friction of glass on glass wetted with water. An appeal to capillary forces of this type will not solve the paradox.

Some light is thrown upon it when we inquire into the state of the surface of glass that has its friction increased by water. Surfaces of glass "cleaned" in the ordinary way by rubbing with a glass cloth, or glass faces which have been simply exposed to the air, are in point of fact not clean, but highly lubricated with a film of matter derived from the cloth or condensed from the atmosphere. This "grease" film is of invisible thinness. It is probably of the order of 1 $\mu\mu$ in thickness—that is to say, one-millionth of a millimetre. It can be removed by soap and water, which in turn must be removed by a stream of water, and the plates dried in clean air out of contact with solids. The film reforms quickly—very quickly in London air, and less quickly in the country. A "grease" film also creeps over a cleaned glass face from ordinary solids with which it may be in contact. Still, when due precautions are taken—and they are many—it is possible to get a glass face which seems to be really clean.

The first property of clean faces is that their friction, one for the other, is very high; indeed, it is impossible to make them slip past one another. One glass plate may be forced past another, but true slipping does not take place; they tear at the point or points of contact. It is easier, in short, to disrupt the actual substance of the glass itself than to get the surfaces to slip over one another. Clean glass faces "seize" when they touch.

When chemical substances are tested as lubricants on clean glass faces, a remarkable fact emerges—namely, that some are quite neutral in that they do not alter the resistance to slip in the least; such are water, alcohol, benzene, and strong ammonia. Other substances have some lubricating action, great or small—that is to say, they decrease the force needed to produce slipping; such are the alkalis, trimethylamine and tripropylamine, the fatty acids—*e.g.* acetic acid—and the paraffins. Those fluids which act as lubricants are not necessarily fluids of any considerable viscosity; indeed, a high viscosity is compatible with the absence of any lubricating action other than flotation. Thus glycerine facilitates the slipping of clean glass on clean glass only when it is present in quantity sufficient to float the surfaces apart. On the other hand, acetic acid and tripropylamine—substances of low viscosity—are admirable lubricants of glass.

None of the fluids tested was found to raise the friction of clean glass faces. They were either neutral, or decreased friction to a greater or less extent. The power of increasing the friction of glass faces which neutral fluids, such as water, possess is due, not to their action on the glass itself, but to the fact that they interfere with the action of the invisible grease film. Water on an ordinary glass face acts as an anti-lubricant; on really clean glass it is "neutral."

All solid faces, however, do not distinguish chemical substances into those which are "neutral" and those which possess lubricating properties. Nearly one hundred substances have been tested on burnished faces of bismuth, and in every case some decrease of friction was observed.

A comparison of the lubricating action of simple chemical substances on clean faces of glass or of bismuth would seem to show that the quality of oiliness is due to some reaction between the substance and the solid face. Much is still obscure, but certain facts seem to be capable of interpretation in no other way. Thus water and ethyl alcohol have no detectable lubricating action on clean glass, whilst both are moderate lubricants for clean bismuth.

The thickness of the layer needed to lubricate is astonishingly small. It is quite invisible, and probably only one or a very few molecules thick. To discuss this adequately would take too long, but the fact may be instanced by an experiment of great beauty. A tiny drop of, say, acetic acid or tripropylamine is placed near one corner of a plate of clean glass 6 cm. square; nothing detectable by the senses happens; the drop is there, and that seems to be all. But the whole surface of the plate has, in fact, been changed fundamentally. It is now fully lubricated by an invisible film which has spread rapidly over it from the drop. The presence of this film may be detected by measuring the friction or by following the migration of two drops of fluid over the face of the plate. It will be found that the drops attract one another under conditions which point to the cause being the contractility of the invisible film.

This brings me to the second part of my subject—namely, the relation of lubricating power to chemical constitution.

In particular experiments with bismuth, a slider having a curved surface was applied to a plain surface of metal, both surfaces being highly polished, and the force required to initiate movement was measured. This force measures what is usually called static friction as opposed to the kinetic friction when the surfaces are in relative motion. The static friction was found to be a function of the weight of the slider. Therefore, the ratio of the weight of the slider to the friction was used as a relative measure. The results appear in the following table:—

Static friction 0·5 when the faces were clean.

CHAIN COMPOUNDS.

Alcohols.

	Static Friction.		Static Friction.
Methyl	0.29	*iso*Propyl	0.32
Ethyl	0.32	*iso*Butyl	0.30
Propyl	0.34	Allyl	0.29
Butyl	0.30	Glycol	0.30
Amyl	0.27	Glycerol	0.22
Octyl	0.25	Penterythritol ...	0.40
Cetyl	0.17		

Acids.

	Static Friction.		Static Friction.
Formic	0.45	*n*-Octane	0.32
Acetic	0.40	Stearic	0.15
Propionic	0.31	Oleic	0.10
Valeric	0.28	Ricinolic	0.02
Caprylic, fluid ...	0.19	α-Lactic	0.20
Caprylic, frozen on plate	0.05	Glyceric	0.22

	Static Friction.		Static Friction
Acetone	0.32	Ethyl ether ...	0.33
Methyl ethyl ketone	0.29	B.P. "Paraffin"	0.20
Ethyl acetate ...	0.36	Solid paraffin, m.p. 30.5°	0.09
Ethyl valerianate...	0.35	Solid paraffin, m.p. 46°	0.07
Tristearin	0.24	Carbon tetrachloride	0.43
Triolein	0.14	Chloroform ...	0.30
Acetone dicarboxylic diethyl ester ...	0.29	Amylene	0.26
n-Hexane	0.37	Octylene	0.28
n-Heptane	0.346	Butyl xylene ...	0.27

RING COMPOUNDS.

	Static Friction.		Static Friction.
Benzene	0.34	Ethyl cinnamate ...	0.32
Ethyl benzene ...	0.32	Thiophenol ...	0.22
Iodobenzene ...	0.30	Benzyl hydrosulphide	0.23
Toluene	0.28	Pyridine	0.33
Xylene	0.30	Piperidine	0.32
p-Cymene	0.31	Naphthalene ...	0.29
Phenol	0.25	Anthracene ...	0.26
Catechol	0.39	β-Naphthol ...	0.38
Quinol	0.40	Naphthoic acid ...	0.39
m-Cresol	0.26	Carvacrol	0.23
Benzyl alcohol ...	0.31	Thymol	0.24
Benzoic acid ...	0.38	Menthol	0.26
Phthalic acid ...	0.37	Dipentene	0.31
Cinnamic acid ...	0.27	Camphor	0.24
Benzilic acid ...	0.45	Active ethyl ester of camphor oxime	0.33
Salicylic acid ...	0.41	*iso*Cholesterol ...	0.27
Ethyl benzoate ...	0.33		
o-Phthalic ester ...	0.27		
Ethyl hydrocinnamate	0.28		

CYCLIC COMPOUNDS.

	Static Friction.		Static Friction.
*cyclo*Hexane ...	0.31	*cyclo*Hexanone ...	0.35
Methyl *cyclo*hexane	0.30	1 : 2-Methyl *cyclo*-hexanone ...	0.32
1 : 3-Dimethyl *cyclo*-hexane	0.29	1 : 3-Methyl *cyclo*-hexanone ...	0.35
*cyclo*Hexanol ...	0.20	1 : 4-Methyl *cyclo*-hexanone ...	0.33
1 : 2-Methyl *cyclo*-hexanol	0.28		
1 : 3-Methyl *cyclo*-hexanol	0.25		

Ammonia fortiss....	0.34	Castor oil	0.03
Triethylamine ...	0.30	Water	0.33
Tripropylamine ...	0.26		

It will be seen that static friction is a function of the molecular weight of the lubricant, and in a simple chemical series of chain compounds, such as fatty acids and alcohols or paraffins, a good lubricant will be found if one goes high enough in the series; but it is not a simple function. The friction, for instance, rises sharply in moving from $CHCl_3$ to CCl_4, and from phenol to catechol and quinol. The influence of molecular weight is overshadowed by the influence of chemical constitution.

In some simple chemical series the relation appears to be a linear one. Examples are paraffins and the series benzene, naphthalene, anthracene.

The relation of lubricating qualities to viscosity broadly resembles that to molecular weight. In a simple chemical series lubrication and viscosity change in much the same way with molecular weight, but that there is no fundamental relation between viscosity and lubrication is shown by the following figures:—

	Viscosity at 20°.	Static Friction.
Carbon tetrachloride	0.0096	0.43
Chloroform	0.0056	0.30
Acetic acid	0.0122	0.40
Octylic acid	0.0575	0.19
Benzene	0.0065	0.39
Toluene	0.0058	0.28
Benzyl alcohol	0.0558	0.31

Fluidity of the lubricant has no constant significance. The curves for acids, alcohols, and paraffins show no break where, with increasing molecular weight, the lubricant becomes a solid at the temperature of observation. Compare also benzene, naphthalene, and anthracene, menthone and menthol, thymol and carvacrol.

Perhaps the most unexpected result is the distinction between ring and chain compounds. The simple ring compounds, benzene, naphthalene, and anthracene, show the linear relation to molecular weight, and values are much the same as those for paraffins of the same molecular weight. The similarities, however, end here, for any change in the molecular structure produces opposite effects according as it takes place in a chain or a ring. Thus a double bond decreases the lubricating action of a ring compound, but increases that of a chain compound. As examples, compare naphthoic acid with double-bonded oxygen, with naphthalene, menthone with menthol, *cyclo*hexanone with *cyclo*hexane, benzoic acid with benzene. As examples of double-bonded carbon, compare cinnamic ester with hydrocinnamic ester, dipentene, having two unsaturated carbon atoms, with menthol and *cyclo*hexane. Also the more saturated cyclic compounds are better lubricants than the less saturated ring compounds. When a ring and a chain are joined, as in butyl xylene, the result is a better lubricant than either.

The esters occupy a quite unexpected position. The simple aliphatic esters are worse lubricants than their related acids and alcohols. The ring esters, on the contrary, are better lubricants than are their related acids (*e.g.* ethyl benzoate and benzoic acid).

Perhaps the most interesting substances are the hydroxy-acids with CH and COOH groups. This conjunction produces a remarkable increase in the lubricating power of a chain compound (lactic acid and ricinolic acid), and almost destroys lubricating action in the case of the ring compounds (salicylic and benzylic acids).

In the ring compounds the replacement of hydrogen decreases lubricating power in the case of N, :O, or .COOH, and increases it in the case of other groups in the order $C_2H_5 < CH < OH$.

The effect of a second group of the same or of a different kind is to decrease the effect of the first. Compare, for instance, toluene with xylene; catechol, quinol, and cresol with phenol; and methyl *cyclo*hexanol with *cyclo*hexanol. The simpler the group, the more effective it is. Compare cymene with toluene or xylene, and benzyl alcohol with phenol.

When the atoms are disposed with complete symmetry about a carbon atom, the result is a very bad lubricant, as we see in carbon tetrachloride and the alcohol penterythritol

$$C(CH_2{\cdot}OH)_4.$$

It will be noticed that no ring compound is a good lubricant. Even cholesterol with the molecular weight 366 is no exception.

The group SH acts much as the group OH, thiophenol, $C_6H_5{\cdot}SH$, and benzyl hydrosulphide, $C_6H_5{\cdot}CH_2{\cdot}SH$, resembling phenol and benzyl alcohol respectively.

Concerning one matter—and that the most fundamental—some conclusion must be reached, even though it be upset later. What is friction due to? The "Encyclopædia Britannica" is in no doubt as to this. Friction, it says, is due to inequalities of the surface. This conclusion cannot, I think, be accepted. Why, if it be true, should clean burnished faces of glass or bismuth refuse to slide over one another? It does not even accord with such simple facts as we now know. For instance, the friction of an optical face of glass was found to be the same as that of ordinary plate glass within the limits of accuracy aimed at; and both the optical face and the ordinary plate were found to give higher values than ground glass.

The subject cannot be fully discussed here, but I think we may conclude with some confidence that the friction both of lubricated and of clean faces is due to true cohesion—to the force, that is, which binds together the molecules of a solid or of a fluid. If there were no seizing, there would be no friction. The function of the lubricant is to diminish the capacity for seizing by saturating more or less completely the surface forces of the solid. In some cases it seems to abolish it completely, so that static friction vanishes.

The subject of lubrication is of interest to the engineer, but it is perhaps of more interest to the physicist, for it offers a means of exploring the most difficult regions of the physics of boundary zones—namely, the surface energy of solids. It will, for instance, I believe, enable us to prove that the simplest chemical change at the surface of a metal takes place only when the surface energy is decreased thereby. The film of oxide of sulphide which forms on copper acts as a very effective lubricant, and it acts also like a grease film in preventing water from wetting the surface; and from both of these facts we may conclude that the presence of the film lowers the surface energy of the metal.

Obituary.

Prof. Italo Giglioli.

Among the famous band of workers who built up a scientific agriculture in the nineteenth century the name of Italo Giglioli will take a high place, not only for what he did himself, but also for what he inspired others to do. Both his father and his grandfather had become exiles from Italy in the turbulent days of the early revolutions; the father came to Edinburgh, took a medical degree, and then settled in London to practise. The revolution of 1848 attracted him back to Italy, where, in 1852, at Genoa, a son was born to him to whom the name Italo was given as the first to be born in the native land.

Italo Giglioli devoted himself to the teaching of scientific agriculture, which he believed to be his country's great need. He was elected professor at the age of twenty-four, and taught, first at Portici, and then at Pisa, where he stayed until his death, on October 1, at sixty-eight years of age, playing a great part in the development of these two schools to their present honourable position. For this work he was well fitted. He had an unusually good knowledge of English and of other languages besides his own, and was thoroughly familiar not only with the investigations of Lawes and Gilbert at Rothamsted and of other British agriculturists, but also with the French and German work. In 1888 he drew up a long report for the Italian Ministry of Agriculture on British agricultural education (*Annali di Agricoltura: Educazione Agraria Britannica*, Rome, 1888), written with full knowledge, and containing much information that the student could obtain elsewhere only with difficulty. He kept up his interest in English investigations throughout his working life, and was usually appealed to by English workers who desired information about Italian agriculture.

Giglioli's published work covers a wide range; on the physiological side it deals with the functions of essential oils in plants (*R. Accad. dei Lincei*, 1911, vol. xx.); the biological absorption of methane, in which he confirmed the conclusion of Söhngen and Kaserer that methane is oxidised by certain micro-organisms (*Studi e Richerche*, Pisa, fas. 22, 1909-14); and the resistance of seeds to chemical agents. It is not, however, as a worker on abstract laboratory problems that Giglioli will be remembered. His more important investigations were on the agricultural side. He carried out experiments at the Experimental Station at Suessola on the cultivation of wheat, summarised in "Il Frumento: sue varietà e concimi" (Portici, 1888), and in later reports. In these he dealt with varieties, manuring, and such special cultural treatments as the effect of electrification, of manganese, etc. He also dealt with the cultivation of the cork tree ("La cultura del Sughero," Portici, 1902); the effects of chemical manures in arid climates; phylloxera; and silage—all important subjects in Italian agriculture.

Giglioli's best work was probably as a teacher, and some of the tributes paid by his students are very touching. His book, "Chimica agraria campestre e silvana" (Naples, 1884 onwards to 1902), was much used in Italy. The more general agricultural questions are discussed in his well-known "Malessere agrario ed alimentare in Italia" (Portici, 1903). This contains probably the best available summary of Italian agricultural conditions in comparison with those of other countries, and also an examination of the causes and possible remedies for agricultural distress.

Giglioli's death severs a link between British and Italian agriculturists, and is equally regretted in both countries. It is the hope of all concerned that the close relationship for which he strove may be maintained and strengthened.

E. J. Russell.

Dr. C. A. Sadler.

Dr. Charles A. Sadler was a student at Liverpool in the early days of the University there. After graduating with honours in physics (1905), he joined Prof. Barkla—then lecturer in the University—in his investigations of the secondary rays emitted by substances exposed to Röntgen radiation. Sadler's introduction to the work was made in a detailed investigation of the absorption of the characteristic X-radiations.

The results of these researches were published by Barkla and Sadler in a series of papers in the *Philosophical Magazine* dealing principally with the laws of X-ray absorption, the homogeneity of the characteristic radiations, and the relation between the characteristic radiations and the atomic weights of the chemical elements emitting them. Sadler afterwards (while holding the Oliver Lodge fellowship) continued the investigation of the energy of the characteristic radiations by an accurate and detailed examination of these radiations from several elements. He also applied Townsend's method to a study of the secondary corpuscular radiation, and found that a certain portion of this radiation was associated with the characteristic X-radiation.

In 1911 Sadler was appointed lecturer in physics at University College, Reading. There he became interested in mechanical work, and in 1915 he turned his skill to good account by organising most successfully a training centre for munition workers. Shortly before the armistice he left academic work to undertake research of a technical character with Messrs. Allen and Simmonds, of Reading. This work was, however, cut short by a breakdown in health, followed by his early death on December 5.

Sadler's interest and skill in mechanical methods were exceptional. He was an able experimenter, an accurate observer, an indefatigable worker. These gifts were very highly esteemed by those with whom he collaborated.

Notes.

THE Dyestuffs (Import Regulation) Bill was read for a third time in the House of Lords on December 23 and has been given Royal assent. The measure was referred to in the King's Speech at the close of the session as "the Act regulating the importation of dyestuffs, in order securely to establish the dyestuffs industry in this country."

WE begin this week the publication of a Calendar of Scientific Pioneers, which it is proposed to continue throughout the year. There is inspiration as well as interest in the lives and work of the great men of science thus recalled to memory, and many readers will, we believe, welcome this additional feature in the columns of NATURE. The Calendar has been prepared by Engr.-Comdr. Edgar C. Smith, H.M. Dockyard, Devonport, who has for many years been engaged in compiling biographies of all leading contributors to the advancement of natural knowledge.

A GREAT earthquake on December 16 is reported from the province of Kansu, on the Upper Hoang-Ho, in north-west China. The city of Ping-liang was much damaged, and 2000 persons are said to have perished. Prof. H. H. Turner and Mr. J. J. Shaw, in the *Times* of December 28, give reasons for believing that this earthquake was the origin of the great seismic disturbance registered on December 16. With regard to the suggestion of an Alaskan origin referred to last week (p. 542), it may be of interest to recall the last great earthquakes in that country. They occurred on September 3 and 10, 1899, the latter being the more violent. Though the seismographic evidence implied an origin in or near Alaska, no direct evidence reached this country until September 26, when the *Times* of that date published a short account of the violent earthquakes in Yakutat Bay. The magnitude of the disturbance was not, however, realised until 1905, when Messrs. Tarr and Martin showed, from the evidence of dead barnacles and mussels still adhering to the cliffs, that the uplift of the crust was in one place as much as 47 ft. 4 in.

THE third half-yearly report on the progress of civil aviation has just been issued as a White Paper (Cmd. 1073). It is an interesting document in view of the prevailing conditions in the industry, and holds out hope of a more prosperous future. It is pointed out that regular air services have now been established from London to Paris, Brussels, and Amsterdam, and that passenger, mail, and goods traffic is increasing. The total number of aeroplane miles flown in the half-year ending September 30, 1920, is nearly 700,000, whilst the aggregate since May, 1919, exceeds 1,000,000. The number of passengers by air exceeds 30,000, whilst the goods carried weigh little less than 90 tons. In value the imported goods exceed 500,000*l*., whilst the exports and re-exports are about half that amount. As part of the mail services, about 50,000 letters have passed each way between London-Paris, Brussels, and Amsterdam with a regularity which is notable. Of the three routes the best shows 94 per cent. of deliveries within three hours of schedule time, and the worst 76 per cent. As part of the organisation for further improving these records, it is stated that the wireless direction-finding apparatus installed at Croydon has proved its value, enabling aircraft to correct their course in thick weather. The equipment of aircraft with apparatus for wireless telephony is extending, as it is found to be of considerable assistance to navigation. The fatal accidents are given as in the ratio of 1 per 50,000 miles flown or per 5000 passengers carried. The international character of flying is prominently brought out in a concise statement of activities in other countries than Britain, and shows a breadth of interest which will stimulate efforts to overcome the present difficulties experienced by those engaged in civil aviation.

H.M. STATIONERY OFFICE has published an Interim Report on Glass Bottles and Jars and Scientific Glassware, prepared by a Sub-Committee appointed by the Standing Committee on Trusts and adopted by the Standing Committee (Cmd. 1066, price 2*d*.). The section on scientific glassware is of great interest and importance to all scientific users. After pointing out that prior to the war the whole of the scientific glassware used in this country was imported from enemy countries, principally Germany, the Committee describes the efforts made by certain manufacturers of glass bottles, under inducements by the Government, to develop the scientific glassware industry in Great Britain. The report points out that British manufacturers have to meet to-day foreign competition the nature of which may be gathered from the fact that, "favoured by 'exchange' rates and other conditions, goods of the kind now being made in this country are being supplied by Continental manufacturers at prices less than the actual cost of manufacture here, whereas for goods that are not yet being manufactured here prices are being charged by the Continental makers which mean to the consumer approximately five times the pre-war price of such goods." Finally, after declaring that it is outside its functions to report on the demand of the industry for a prohibition of imports of scientific glassware except under licence, the Committee says: "We cannot refrain from expressing the hope that his Majesty's Government will not find it impossible to implement the verbal assurances said to have been given to manufacturers; for it would appear to be only in that way that this country can be saved from returning to the pre-war position of dependence upon foreign countries for their supplies. We would add that, in our view, at the same time users of such glassware should also be safeguarded as to prices, and that the desired assistance should only be given for a limited period, with powers of withdrawal if it were found that manufacturers were in any way inclined to take advantage of the situation by unduly raising prices."

THE Annual Report of the Chief Medical Officer, 1919–20, Ministry of Health, has recently been issued, being the first annual medical report of the Ministry of Health. The greater part of the volume is occupied with a survey of the general health, of epidemiology and infectious diseases, and of the work of the sections into which the Medical Department of the Ministry of Health is now divided. In the appendix to the volume Dr. Monckton Copeman discusses the relationship of smallpox and alastrim in connection with an outbreak of an anomalous varioloid disease in Norfolk. The disease was introduced from some locality in the Mediterranean area, and, although undoubtedly of the nature of smallpox, would seem more closely to resemble that variety which has been studied in Brazil known as "alastrim." Sir David Semple also gives a brief account of rabies and of the various systems of anti-rabic inoculation.

THE Research Defence Society has published an essay on "Vaccination" by Dr. Mary Scharlieb. A brief history of smallpox inoculation and of Jenner's work on the introduction of vaccination is given, followed by a short account of the symptoms of unmodified smallpox. The "Leicester experiment" is next described and discussed at some length. Finally, the outbreaks of smallpox at Dewsbury, Ravensthorpe, Gloucester, and Glasgow are referred to, and the influence of vaccination on the incidence and mortality of the disease is considered. The essay should be useful to those who desire to have evidence of the value of vaccination. The essay (together with others on the work of the Medical Research Committee, on the value of experiments on animals, and on the prevention of tetanus during the war, already noticed in these columns) may be obtained from the Secretary, 11 Chandos Street, W.1, price 2s. the set.

ANCIENT Oriental chemistry and its allied arts are discussed in the November issue of *Man* by Mr. Masumi Chikashige. The author begins with a review of ancient chemistry in Japan and China, consisting in the latter country of two parts: theories and gold-making, the latter having in its turn two aims, wealth and eternal life. He then passes on to the question of bronze in China and Japan, and supplies a series of analyses of its component elements. Finally, he describes the manner in which iron swords are forged. He concludes by saying: "We may recognise now some resemblance to damascened steel. If the Japanese learned this method of welding from the naturalised Chinese, where had the latter learnt their art? Whether it was their own, which made its way westward to Europe through India and eastward to Japan, or whether, on the contrary, they learned the art from India, is not now to be settled."

THE Asiatic Society of Bengal has published among its Memoirs (vol. vii., No. 3) an important paper by Mr. J. Hornell on "The Origins and Ethnological Significance of Indian Boat Designs." Surveying the shores of the Indian peninsula, Mr. Hornell describes, with good illustrations, the various types of boats now in use and many ceremonies in connection with their launching and employment, with a review of our knowledge of the ancient sea-trade with India. The most interesting part of the paper is an attempt to show how foreign influences have created or modified the types which exist at present. Thus he suggests that compound masts are essentially Mongoloid in origin, being seen to-day among Burmese, Indonesians, and the southern Chinese, and that on the west coast the use of the outrigger for coasting vessels was discarded at a comparatively early period under the influence of seamen from the Persian Gulf and the Red Sea. Also, since the single outrigger and balance-board designs are both Polynesian in affinity, their general diffusion on one or the other of our Indian coasts points to the conclusion either that some of the coast-folk of India are closely allied to the races of Oceania or that it is due to trade relations. Inland boat designs are on a very different footing, the first and larger group having distinctly Egyptian affinities, and the other equally well-marked Babylonian relationship.

THE second volume of the Proceedings of the Lahore Philosophical Society, which forms a record of the papers read before the society during the years 1916–20, has been received. The first volume contained papers read during 1914–16; we gather that lack of funds has prevented the issue of this second volume until the present time, and that publication has now been made possible by a grant of money from the Punjab University. The present volume, of eighty pages, contains records of thirty-two papers, of which eight are printed *in extenso* and the remainder in abstract. The papers are of two kinds: records of original work and summaries of recent researches; the mathematical, physical, and biological sciences are all represented. The membership roll is about fifty, and meetings are held every month during the academical session. A society such as this fulfils an important function in the intellectual life of a comparatively remote and isolated community. While authors of original researches will presumably publish them in other periodicals as well as in these pages, the present volume forms an interesting record of the activities of a society on the successful foundation and continued existence of which the members are to be congratulated.

WE have recently received a small booklet dealing with a proprietary fluid which has been placed on the market under the name of "Solomia." It is claimed to destroy any large insect pest—aphids, bugs, spiders, caterpillars, worms, etc. Further, it is stated to be non-injurious to crops, fruit, or grass, and its efficacy to be unaffected by weather conditions. If "Solomia" can effectively carry out all that its promoters claim for it, there is no doubt that it is a very remarkable mixture.

IN the December issue of the *Entomologist's Monthly Magazine* Mr. F. W. Edwards writes on the British species of Dixinæ. This subfamily includes a small number of gnat-like insects commonly regarded as constituting a family of their own. They are related both to mosquitoes (Culicidæ) and to crane-flies (Tipulidæ), and Mr. Edwards places them in the first-mentioned family. Their larvæ and pupæ are exclusively aquatic, and bear a rather close resemblance to those of Anopheles and its allies. The only genus is Dixa, which enjoys the position of never having had the validity of its name questioned, and, consequently, no synonym exists. Ten British species are recognised, but they have been so little collected that we have only a very vague idea as to their distribution in this country. In the same periodical Mr. J. E. Collin gives useful keys to the British species of the Sylvaticus group of the genus Pipunculus. Since Mr. Verrall dealt with them in his "British Flies" (vol. viii.) further material has accumulated, rendering a revision of the genus necessary.

THE status of the rook in its relation to the farmer, fruit-grower, and forester is briefly reviewed by Dr. W. E. Collinge in the *Journal of the Ministry of Agriculture* for December. Dr. Collinge is of opinion that this bird has become too numerous, and, as a consequence of the stress of competition, it has taken to feeding upon cultivated crops. He contends that if repressive measures were put into force and carefully carried out the rook would soon assume its normal place again, and prove to be one of the most useful birds to the farmer in helping to control the larvæ of such injurious insects as click-beetles and crane-flies. The rook to-day, the author estimates, consumes about 80 tons of cereals, 32 tons of potatoes and roots, 7½ tons of insects beneficial to the farmer, and 65 tons of injurious insects, slugs, snails, etc. This last item is significant, and suggests an extension of this analysis directed to show approximately how many tons of cereals, potatoes, and roots would have been consumed by the 65 tons of injurious insects and their offspring if they had not fallen a prey to the rook.

IN No. 15 of the Economic Proceedings of the Royal Dublin Society (November, 1920) Prof. G. H. Carpenter reports on the injurious insects and other animals observed in Ireland during the years 1916–18. Among the various pests mentioned are larvæ of a species of Bibionid fly which caused much damage in wheat-fields by feeding on the roots, and those of *Bibio Marci*, L., found attacking potatoes stored in a pit. The flax flea-beetle (*Longitarsus parvulus*, F.) caused serious injury to the flax crop during the three years under review, and it was found necessary to re-sow the crop in several localities, no method of control being referred to. Storehouse beetles (*Ptinus fur*, L., and *P. tectus*, Boield.) are recorded as devouring very varied substances. Those of the first-mentioned species are believed to have been introduced from Tasmania, and were noted in 1908 in a consignment of almonds, and in 1911 from stuffed birds. Early in 1918 *P. fur* was received from Dublin localities among seeds of henbane intended for sowing, while *P. tectus* was discovered in a chemist's store of casein. The report is adequately illustrated, but shorter than many of its predecessors, which is possibly accounted for by the war and by conditions in Ireland generally.

THE first Report of the National Institute of Agricultural Botany, recently issued, shows that encouraging progress is being made with the new scheme. The aim and policy of the institute are to develop new and reselected varieties of all kinds of farm crops and to "grow on" promising types until sufficient stocks are available for distribution through the seed trade to the farmer. Liberal financial assistance has been forthcoming, not only from private benefactors, but also from the seed trade and farming industry. As the official seed-testing station is to be incorporated with the institute, a building grant and loan were obtained from the Development Commission. It is now hoped to gain new subscribers to build an adequate maintenance fund. The headquarters of the institute, now rapidly approaching completion, are being erected at Cambridge, and include housing accommodation for a portion of the staff. The rest of the 36 acres of this site is available for trial grounds. In addition, the Hiam Farm at St. Ives (Huntingdonshire) (354 acres) will be used as a seed multiplication farm, and 39 acres of rich market-garden land at Ormskirk, Lancashire, are being developed as the potato testing station. Mr. Wilfred H. Parker has been appointed director of the National Institute, but the Seed Testing Station will retain its independence under its own director, and will be equipped to test all kinds of agricultural, garden, or forest seeds. It is hoped that the buildings will be ready for occupation by August, 1921, and arrangements are being made whereby the work of the institute will be carried on with the least possible delay.

THE possibility of a general world-wide sinking of sea-level to the extent of nearly 20 ft. during post-Glacial times is discussed by Prof. R. A. Daly in the Proceedings of the National Academy of Sciences (Washington) (vol. vi., No. 5), and at greater length in the *Geological Magazine* (vol. lvii., No. 672). Observations on coast-lines in many parts of the world show approximately this degree of emergence, and the facts appear to warrant belief in synchrony in the age of the strands. Prof. Daly, however, points out that the suggestion is published, not to express a fixed conclusion, but to invite criticism and to test the idea in different parts of the world. If this emergence is established throughout the world, its explanation cannot be found in a change in the earth's centre of gravity or in a change in its speed of rotation. Prof. Daly suggests an increase in the past in the volume of existing ice-caps as a possible explanation. He calculates that a thickening of the Antarctic ice-cap to the average amount of 700 ft. would lower the sea-level by about 20 ft. by the abstraction of water from the ocean basins.

A REPORT on two pilot-balloon ascents made at Shoeburyness by Mr. N. K. Johnson is published by the Meteorological Office as Professional Notes No. 13. Both ascents were made on February 18 last. It is claimed that the results indicate the limitations and uncertainty of the single-theodolite method of observation, while they show the accuracy obtainable in determining upper-wind velocities and directions by the double-theodolite method. The first ascent was observed for 74 minutes, and in 48 minutes had attained 26,400 ft. The balloon then apparently developed a leak, and sank continuously to 12,800 ft., when it was lost in a light bank of haze. The second ascent was started at 11.50 a.m., 85 minutes after the first ascent, and was followed for 116 minutes. The balloon rose to 32,000 ft. in 64 minutes, which is said to be in excellent agreement with the rate of ascent given by Dines's formula. It afterwards maintained a practically uniform height until the 93rd minute, and afterwards fell slowly to 27,000 ft., when it was lost to view. Both balloons were followed by two theodolites 4290 ft. apart, and also by a range-finder. The results obtained from the range-finder are said to be very much less accurate than those given by the two theodolites, both the heights and the distances by the range-finder being consistently low by about 10 per cent.

MR. N. A. ALLEN read an interesting paper on the current density in the crater of the carbon arc to the Physical Society on December 10. By using an arc between a positive carbon and two negative carbons in the same plane, but inclined to the positive at 100°, he found that the crater was a circular plane which could be easily focussed on the screen and accurately measured. The distance between the carbons corresponded to the largest "silent" current. Ten minutes were allowed to elapse before a reading was taken, so that the crater had time to assume its normal size. Under these conditions Mr. Allen found that with a maximum inaccuracy of about 1 per cent. the area of the crater in millimetres was equal to the current in amperes multiplied by 1·34. The experiments were made with currents varying between 2·5 and 10 amperes.

A THIRTY-PAGE pamphlet on "Optical Methods in Control and Research Laboratories," just published by Messrs. A. Hilger, Ltd., will prove of great use to works physicists and chemists concerned in the determination of the refractive indices, absorptions, or optical rotatory powers of materials. As a rule, such determinations must be made on direct-reading instruments, but it is desirable that the observer should understand the principles of the instrument which he uses, and be able to tell at once when it has gone wrong and to set it right. The pamphlet contains tables of the ranges and sensibilities of the different types of instruments and gives numerous references to books and memoirs in which further information may be found.

THE October quarterly number of the Journal of the Society of Glass Technology contains an article by Dr. W. E. S. Turner on "Some Developments in the Study of Glass Technology in the Year 1919–20." Dr. Turner states that during the war this country produced chemical glass "second to none in the world so far as chemical resistance was concerned"; and that as regards optical glass, glasses superior to those produced at Jena have been made on a commercial scale in this country, and also in very great variety. If it were a question of quality only, Dr. Turner adds, then we could very reasonably hope to maintain our market intact. But the existing rates of exchange in certain foreign countries operate to the disadvantage of the industry in this country. The article reproduces the fourth annual report of the Delegacy for Glass Research, from which it appears that, besides a considerable output of research work, much has been done to resuscitate the educational work of the University of Sheffield in the department of glass technology. An appendix to the report gives a list of the researches either planned or already in progress. Many of these researches are in fields in which other scientific bodies, such as the National Physical Laboratory, the British Scientific Instrument Research Association, and the Glass Research Association, are also working. The journal contains, besides several interesting papers communicated to the society, including one by Dr. George H. Miles on "The Human Factor in Industry," a useful section of abstracts and reviews.

THE report on the heating of buried electric cables which was presented to the Institution of Electrical Engineers on December 17 is of interest to men of science as well as to engineers. The thermal problems in connection with the cables are those principally considered, and important results have been obtained. For instance, it is proved that the thermal conductivity of the paper insulation used in high-tension cables is about three times as great as that of paraffin wax and practically constant. Hence to determine the temperature of the inner cores of the cables carrying given currents all that is necessary is to determine the thermal resistance of the earth in contact with the lead sheath. The thermal conductivity of earth containing 15 per cent. of moisture was found to be five times greater than that of the paper insulation. Hence by elementary calculations it is now possible to calculate the temperature rise of cables carrying given currents when laid in certain soils. A curious result found by one of the experimenters was that a cable when buried 4 ft. under the ground heated more than when it was only buried 1 ft. Hence the cooling by air convection of the heated ground in the latter case must have been appreciable. It is of interest to notice the close connection between the problem discussed in this report and the corresponding problems in connection with the electrostatic capacity and the current-flow in cables. Kelvin pointed this out eighty years ago.

A PAPER read by Engr.-Comdr. C. J. Hawkes at the meeting of the North-East Coast Institution of Engineers and Shipbuilders on November 26 contains a great deal of information derived from experiments on the injection and combustion of fuel-oil in Diesel engines. These experiments were carried out at the Admiralty Engineering Laboratory on both the solid-injection and air-injection systems. The engine experimented upon was a single-cylinder four-stroke engine having a piston of aluminium alloy, 14½ in. diameter by 15 in. stroke, developing 100 brake-horse-power at 380 revolutions per minute. The paper is very long, and it is possible to make reference to one or two points only. One of the later tests with solid injection gave an average fuel consumption of just under 0·4 lb. per brake-horse-power per hour when developing 100 brake-horse-power at 380 revolutions per minute. The sprayer used in this test had five 0·016-in. holes, with flats, and a fuel-valve roller clearance of 0·003 in. In this test the piston had been fitted with an obturator ring, which proved beneficial. In all the tests the best all-round results were obtained from this sprayer. Taking the fuel-oils experimented with in these tests, it has been found that up to about 100 lb. per sq. in. mean indicated pressure the fuel consumption with solid injection is approximately the same as the fuel consumption with air injection at the same power and speed after taking into account the power required to drive the injection compressor. On an i.h.p. basis the consumption is less with air injection, thus indicating that the combustion is better with air injection. Those interested in the dynamics of cam-driven valves will find much of value in the paper.

MR. D. BROWNLIE has made a survey of a large number of boiler plants, and in the *Chemical Trade Journal* for August–September he published the individual figures obtained relating to different industries. The details of the performance of sixty typical steam-boiler plants used in chemical works are tabulated, and he discusses their merits and demerits. Since these tests were not applied after careful preparation of the plants, they may be regarded as representative of normal working conditions. The true average net working efficiency for the whole sixty plants was found to be approximately 58 per cent., but the author's experience leads him to the conclusion that a modern plant run on scientific lines will give on the average 75 per cent. net working efficiency for continuous performance, a variation between 65 per cent. with purely refuse coal and 82½ per cent. with the best quality coal being approximately the limits which should exist. If the average efficiency could be raised from 58 per cent. to 75 per cent., obviously a great saving would result, amounting to 285,000*l.* per annum on the sixty plants tested. The reasons given for the low results obtained are insufficiency of grate length, economiser capacity, use of superheaters, and insulating steam-pipe covering. Other causes are that the feed-water is not properly treated to avoid scale troubles, and that the combustion processes are not chemically controlled by the use of recorders. Brickwork and foundations, too, were found in a bad state of repair, with a consequent leakage of cold air. The author criticises the use of chimney draught and steam jets when mechanical draught would serve the same purpose more economically. His great insistence, however, is on the necessity for supervision of the plant according to modern scientific methods, and he proceeds to summarise the rigid system of record-taking, which he believes to be essential if the best results are to be obtained. A number of instruments useful for control purposes are mentioned by name, but, of course, their relative merits and demerits are not subjects which the author can deal with in a single article.

Our Astronomical Column.

SKJELLERUP'S COMET.—The following observation was secured by Prof. Barnard at the Yerkes Observatory:—G.M.T. December 18d. 21h. 55·6m., R.A. 9h. 22m. 13s., S. decl. 1° 37′ 49″. The following provisional orbit was deduced from the observations of December 13, 17, and 18:

$$T = 1920 \text{ Dec. } 13{\cdot}1743 \text{ G.M.T.}$$
$$\left.\begin{aligned}\omega &= 343^\circ\ 47'\ 9''\\ \Omega &= 107^\circ\ 39'\ 23''\\ i &= 23^\circ\ 53'\ 10''\end{aligned}\right\}1920{\cdot}0$$
$$\log q = 0{\cdot}06439$$

Ephemeris for Greenwich Midnight.

	R.A. h. m. s.	N. Decl. ° ′	log r	log Δ
Dec. 31	10 19 36	17 4	0·0776	9·4769
Jan. 4	10 34 53	22 25	0·0838	9·4972
8	10 48 33	27 16	0·0909	9·5220
12	10 59 58	31 29	0·0989	9·5503
16	11 9 40	35 10	0·1075	9·5799
20	11 17 42	38 24	0·1167	9·6115

The comet will not become conspicuous, but should be readily visible until the moon interferes with observation towards the end of January.

THE JANUARY METEORS.—Mr. Denning writes:—"The shower of Quadrantids (or Boötids, as they are sometimes called) is due to recur on the nights of January 2 and 3, and it is likely to be conspicuously visible this year if the weather is clear, for there will be no interference from moonlight. The most favourable time to observe the shower will be in the few hours preceding sunrise or in the early evening. The strength of the shower apparently varies from year to year, but its visible character is much affected by moonlight and atmospheric conditions. The meteors are often brilliant and traverse long flights. In 1918 the radiant point seemed to be 7° or 8° north of the usual position, and the display appeared to be more abundant than usual."

THE MASSES OF THE STARS.—The growth of our knowledge of stellar masses has been slow; it was for a long time limited to the very few cases of binaries the orbits and parallaxes of which were known. The next extension came through the spectroscope, which demonstrated the binary character of Algol variables and the existence of the class of spectroscopic binaries. Although the individual masses of the latter could not be found without a knowledge of the inclination, the results could be used statistically, assuming a mean inclination. One product of this research was the fact that the B stars have large masses.

The idea occurred independently to Russell and Hertzsprung that double stars showing curvature of motion could be used statistically for mass-determination even when the arc described was so short that the orbit could not be deduced. Russell concluded that B stars and giant A stars had an average mass of eight times the sun's, while the mass of the other pairs was about double the sun's.

This latter result was provisionally adopted by J. Jackson and H. H. Furner in a paper read to the Royal Astronomical Society on December 10. They utilised all available orbits of binaries, and also several hundreds of other pairs the relative motion of which showed curvature. The parallax of each pair was deduced on the assumption that its mass was double the sun's; its linear motion was then deduced from its observed proper motion.

The resulting apex of the solar motion is R.A. 273·0°, decl. +33·8°, and speed 19·13 km./sec.; the latter is so close to Campbell's spectroscopic value, 19·5 km./sec., that it fully confirms the validity of the assumption.

H. v. Zeipel, in the course of an article on stellar evolution in the December issue of *Scientia*, states that an attempt is being made at Upsala Observatory to obtain the relative masses of the giant stars of the different spectral types by a study of the grouping of these types in the globular clusters. He says: "One can demonstrate . . . that the massive stars congregate in relatively greater numbers than the light ones towards the middle of the group. By careful study of the distribution of the different types, one can deduce the mass of each." The detailed results are not given.

Education at the British Association.

FOLLOWING the presidential address (see Nature, November 4), the Education Section opened its proceedings by receiving an interim report of the Committee on Training in Citizenship. The report should prove valuable to all who are interested in the welfare and future of their country. *Five hundred extra copies were ordered, and are obtainable by application to the Assistant Secretary, British Association, Burlington House, W.1.* It includes:—(1) A comprehensive syllabus of instruction in civics; (2) an analysis of the Scout scheme of training towards citizenship by Lt.-Gen. Sir R. Baden-Powell; (3) schemes of school management and self-government; and (4) suggestions for organising regional study, and notes of lessons in regional survey.

Bishop Welldon, who presented the report, said that training in citizenship was the chief educational interest of the day, and that he hoped a book would be issued on the lines of the syllabus with the authoritative sanction of the British Association itself.

Sir Napier Shaw, in seconding the adoption of the report, discussed the conditions that make for good citizenship, and suggested that, in the establishment of good government, only experience could guide the peoples in this matter, and that it is the business of education to enable the rising generation to profit by the experience of the past.

Mr. J. J. Clarke, of Liverpool, presented a comprehensive survey of teaching civics to adults. He defined civics as a true conception and a recognition of the incumbent duties which necessarily accompany the association of men passing beyond all question of legal contract, and forming the unseen and unforged links which bind the citizen of this vast Empire to the State. He emphasised the necessity of having teachers practically acquainted with details of their work, and inspired by high ideals and a love of the subject.

Mr. A. Patterson, of Cavendish House, contended that civics should be treated not as a special subject, not as an additional subject for the curriculum, but incidentally as part of, and as one of the chief objects in, other subjects. He urged that the teacher should be the student of civics, and hand it on transformed to the child, adapted to his range of experience and capacity. He thought that various forms of school government, and societies in which the children take an active part, are better than lessons, the children thus learning through their own experience.

The papers read before the section dealt mainly with three important aspects of educational work, viz.:—(1) The relation of schools to life; (2) methods of teaching, and the appraisement of ability in a joint meeting with the Sub-section Psychology; and (3) the place in a national system of education of universities, public schools, training colleges, and higher technical schools.

Mr. A. Linecar read a paper advocating the adoption of a general governing principle guiding all school work, such as the power of concentration of mind. All subjects become then a means to an end, and not an end in themselves—the broader the curriculum, the broader the culture; it becomes possible then to cultivate capacity, to appreciate art, literature, beauty, Nature, and nobility without struggling to attain sectional high efficiency, to give power to be happy, and the possibility of a broad, tolerant, healthy, and full mental life.

Mr. F. M. McTavish dealt with the importance of education for the adolescent, and claimed that it was through secondary education our schools are most closely related to life, for it deals with the link between childhood and manhood, and therefore on the grounds of social expediency secondary schools should be free. They only can adequately meet the need of a well-marked stage in human growth and development, the adolescent stage. Each and all must pass through it, whether their parents live in palaces or in slums, and therefore the kind of education best suited to it ought to be available for all.

In a paper on the industrial aspects of life in its relation to schools, Mr. Bray, Assistant Controller of the Training Department in the Ministry of Labour, directed attention to the importance of awakening both employers and trade unions to their responsibilities towards the youthful worker, claiming that up to the age of eighteen these young people should be treated as workers in course of training, and not as workers only. Statistics show that industry as a whole does not yet recognise the new status of the boy under the Education Act of 1918; no adequate provision has been made for trade teaching, for physical welfare, or for general training. The question is a vital one: to members of trade unions it affects the well-being of their sons; to the employers the efficiency of their future workmen. The schools have a double duty: first to educate industry itself by securing a change of attitude towards the juvenile worker through industrial problems in the upper classes of secondary schools, and secondly to assist industry in the selection and training of its entrants.

An excellent paper by Miss Strudwick reviewed in a very happy form the present position of schools in their relation to life. In it she indicated some of the many causes which prevent them from being as effective as they might be, and some of the reforms which are necessary, emphasising the need for cultivating independence of judgment, an appreciation of good literature, and a profitable use of leisure. Miss Strudwick urged the value of corporate life in schools as a means of developing a sense of responsibility, unselfishness, self-discipline, and freedom of criticism. She suggested that co-education was a more natural and wholesome way of beginning life, although there were many difficulties in the way of its being adopted universally. Her plea for a fuller recognition by the nation of the importance of a teacher's work will be endorsed by all sections of the profession—"that right relation between school and life can be attained only when two conditions are fulfilled, when to those who teach their profession is a vocation and the love and confidence of their pupils a reward beyond price, and when those who do not teach are ready to accept in their midst those who do, and to make them feel that, in the best and truest sense, they belong to the world."

In the discussions that followed the Maharaj Rana of Jhalawar and Prof. Kilpatrick, of Columbia University, took part.

A joint meeting with Section E followed to hear a paper by Prof. J. L. Myres on "The Place of Geography in a Reformed Classical Course." Prof. Myres said that the recent decisions respecting "compulsory Greek" compelled a drastic revision of classical teaching. In place of language teaching he advocated a closer co-ordination between history, literature, and geography, and suggested that the Mediterranean region was exceptionally suited to supplement, by contrast, homeland notions of geography; the ancient narrative and description in translations of man's behaviour under these conditions, and his solutions of social and moral problems in ancient times compared with ours, would admirably serve as a foundation for a reformed classical education.

A joint meeting with the Sub-section Psychology was well supported. Prof. T. P. Nunn reviewed the present trend of thought respecting methods of teaching. He said it was generally recognised now that true learning requires the pupil to be at least an active partner in his own education, and that we have travelled far in this direction of recent years Fixed classes and fixed time-tables could not remain as they are if the individual pupil, with his distinctive powers and needs, was to be the centre of the business. Inspired by Dr. Montessori's success, courageous pioneers here and abroad are following up this revolutionary suggestion with pupils of secondary-school age.

Prof. G. H. Thompson read a paper in which he discussed the question: Do Binet-Simon tests measure general ability? He combated the conclusion based on the results obtained that the general ability evaluated by the tests was in the nature of a general common factor present in all performances.

Dr. Kimmins attracted a large audience to hear his paper on dreams of abnormal children—the deaf, blind, and crippled.

A large gathering assembled on the last morning to hear an address by the Right Hon. H. A. L. Fisher on the place of the universities in a national system of education. In Mr. Fisher's unavoidable absence the address was read by Sir Robert Blair. Mr. Fisher referred to the "general influence which universities exercise in promoting a spirit of liberal inquiry as opposed to that rigid and exclusive system of dogma which centuries ago was the product of intolerant clericalism, and is now, in modern democratic societies, preached by revolutionary or class-conscious sects." "If it be the cardinal requirement of our modern civilisation that a career should be open to talent, then it follows that universities should play a much larger part in the life of the people than historical accidents have hitherto assigned to them." He described how this enlargement was going on even before the war, and how greatly it had been increased as a result of it. In his own opinion the Government scheme of grants, whereby more than 25,000 ex-Service men are now undergoing some form of higher education in our universities and colleges, is destined to exert a permanent influence over the history of university development in these islands. In addition, our universities will be swollen by a further influx of students who otherwise before the war would have gone to Berlin or Vienna. The Education Acts of 1902 and 1918 are providing another source of recruitment through grants for secondary and continuation schools. Mr. Fisher pointed out how the work at the universities was held up for lack of funds, and hoped that private munificence will help to supplement and increase the comparatively moderate grant which the State is able to provide. A great addition to the teaching body of this country is imperatively demanded by the circumstances of the time, and he urged that the quality of the education which is to be given to the rising generations will depend upon the extent to which the universities are enabled to leave their impress upon the teachers of our schools.

Mr. Frank Fletcher, headmaster of Charterhouse, followed with a paper on "The Public Schools in a National System of Education." Public schools at the present time could scarcely be said to form a part of a national system, but Mr. Fletcher argued that the question of this relationship has been raised by the Teachers (Superannuation) Act of 1918. A considerable number of public schools were unable, out of their own resources, to provide a satisfactory pension scheme; they would therefore be compelled to seek Government assistance, which would entail conditions linking them up with the national system. He claimed that no reflections of a derogatory character should apply to those who did ask for State assistance, and that those schools standing out should not be excluded from opportunities of rendering services to the State in direct connection with the national system. The form which this service might take (he said) was tentatively put forward by Mr. Fisher:—(1) That the public school should receive boys from county secondary schools the numbers of which were too small to allow of more than one type of education being given, and yet in which might be one or two boys of promise whose bent did not coincide with that of the school; (2) co-operation in the training of teachers and in the inspection of secondary schools. Mr. Fletcher urged the big public schools to accept inspection by the Board of Education rather than that of the universities, so that inspectors of the smaller secondary schools should have experience of the organisations of the larger type. Such service could be rendered without losing that individuality which was the essence of their existence. The inspectorate would then act as a clearing-house of ideas between all types of schools, and each would learn from the other and the Board from both.

Mr. J. C. Maxwell Garnett described by means of a colour diagram sixteen different types of education, showing their interrelationship, and especially the position of the higher technical schools, in what he hoped would be a national system established in the course of the next ten years.

Miss Wodehurst (Bristol University) submitted a paper on training colleges in a national system of education, and argued that there was still a need for the two-year-trained teachers as against the three- or four-year university student. She urged the desirability of keeping the entrance to the teaching profession sufficiently wide to admit those who were unable to obtain full-time courses of study, and showed that there were many sound and valuable reasons why the training colleges were better able to provide for the two-year student than the universities, especially for those who would have charge of children under twelve years of age. It is well known that capacity to profit by a training college experience extends far beyond those who can reach matriculation standard. The universities of the future could meet this need only by lowering their standards of entrance, not only for attainment, but also for ability; hence the use of the non-university college, with a staff of university-trained specialists and a governing body containing university representatives.

One afternoon was devoted to the question of the supply of teachers. An interesting discussion followed an admirable paper by Mr. Spurley Hey on the present shortage of teachers in elementary schools. The reasons for the shortage Mr. Hey attributed to three causes:—(1) The failure of the Board of Education's policy in throwing over the pupil teachers centres and depending on the secondary school to supply recruits; (2) the failure of the Local Education Authority generally to realise the importance of taking steps to maintain an adequate supply of teachers; (3) the hostile and unsympathetic attitude of the teaching staff towards the L.E.A. in creating a supply. Mr. Hey pointed out how the Board had already taken steps to remedy this serious state of affairs by (1) its pension scheme; (2) additional grants for the payment of better salaries; (3) the establishment of the Burnham Committee; (4) providing avenues of approach to the teaching profession other than through the secondary school; (5) impressing upon the L.E.A. the need for immediate action towards creating an adequate supply; and he urged the Board to further action by providing more generously towards the preliminary education and training of teachers by exacting severe financial penalties on the defaulting L.E.A., and by amending the Teachers (Superannuation) Act so as to allow teachers to accept important educational administrative posts without loss of pensionable service. He suggested that recruits are more likely to come forward when the L.E.A. is prepared to regard existing teachers less as paid employees and more as colleagues in carrying on the educational service, and to give teachers a place in consultative and administrative work through the medium of advisory or Whitley committees, or through membership of education committees. He finally pleaded that teachers should abandon their unsympathetic attitude, and that the profession should unite in endeavours for its own expansion and improvement in the interests of education generally.

An afternoon was occupied in hearing a paper by Dr. Vincent Naser and discussing the organisation of international intellectual relations. A committee was formed to deal with the proposals brought forward. The report of the committee upon the educational value of museums was taken on the third afternoon, and the last one was spent in a very interesting and enjoyable visit to the summer school at Barry.

Agriculture at the British Association.

The papers read at the Agricultural Section covered a wide field, and included several of special horticultural interest. The section was well supported by the workers attached to the agricultural departments at Bangor and Aberystwyth, who contributed a considerable proportion of the papers. The attendance from other parts of the country was, unfortunately, rather smaller than usual.

Following the presidential address, Mr. H. V. Taylor (Ministry of Agriculture) read an important paper on "The Distribution of Wart Disease in Potatoes." This disease appears to have been recognised by Newstead so far back as 1878, but the present serious outbreak dates from about 1898, when specimens of infected tubers were brought to the notice of Sutton's by Kerr, of Dumfries. For a considerable number of years the areas infected by the disease were comparatively small in extent, and limited practically to Lancashire, Cheshire, Staffordshire, and the south of Scotland. Since then the disease has spread with great rapidity, and is now found in all areas north and west of a line from Newcastle to Bristol. The north-east of Scotland, however, is still quite clear. The disease is most prevalent in industrial areas, where potatoes are repeatedly grown on the same ground and where there is a less frequent change of seed. The use of infected seed is the most probable cause of the spread of the disease, and the difficulties of transport in the last two or three years have led to less frequent changes of seed and to the use of seed from infected areas. The fact that certain of the newer varieties of potatoes are very susceptible to the disease has doubtless not been without influence.

By 1910 it was known that certain varieties were immune to the disease, and in 1914 experiments were begun at Ormskirk to ascertain definitely which varieties were immune. In 1918 the trade was invited to send in varieties to be tested, and the number under inspection greatly increased. The results of these investigations have been to show that certain varieties, such as Great Scott, King George V., Majestic, Kerr's Pink, Tinwald Perfection, Arran Comrade, Golden Wonder, Langworth, etc., were immune to the disease. The distribution of seed from infected areas is now controlled by the Agricultural Departments of England and Scotland, and the planting in infected areas confined to immune varieties. Serious problems were involved in the administration necessary to secure adequate control, but by the energetic action of the Departments of Agriculture the difficulties are being largely overcome. The magnitude of the task involved will be realised when it is stated that some 37,500 acres of potatoes in Scotland and about 10,000 acres in England were inspected this autumn to ascertain their trueness of type.

Mr. F. J. Chittenden contributed a paper on "The Experimental Error in Potato Trials," describing a series of experiments which had been carried out at the Experimental Gardens of the Royal Horticultural Society at Wisley in Surrey. The paper dealt first with the various factors which influenced the yield so far as they are known at present, special attention being directed to the conditions under which the seed is grown and kept and to the treatment which it receives previous to planting. It was shown that in carefully conducted experiments when forty plants were taken the experimental error was not more than ± 5 per cent.

Two very suggestive papers were contributed respectively by Messrs. T. Whitehead and C. L. Walton, of University College, Bangor, on "A Preliminary Report on the Parasitic Fungi of North Wales" and "The Agricultural Zoology of North Wales." Mr. Whitehead has made a survey of the chief fungoid diseases attacking the cereal and root crops of the four northern counties, while Mr. Walton has commenced an investigation into the entomological and parasitological troubles of the farmer and stockbreeder, and in particular into certain diseases affecting sheep. The work in both cases has scarcely got beyond its initial stages, but promises to yield useful results.

Capt. R. Wellington, of the Ministry of Agriculture, gave the results of "An Orchard Survey of the West of England," while Mr. R. G. Hatton described the investigations which had been carried out on fruit-tree stocks at the Experimental Station, East Malling, since 1912. Mr. Hatton pointed out that the trade had long since discarded even the obvious dividing lines of vigour and growth characters, let alone the precise distinctions of species. The first work, therefore, was that of classification, and stocks of far greater uniformity than was available in the past are now at the disposal of future investigators.

Mr. S. P. Wiltshire described the methods of infection of apple-trees by *Nectria ditissima*, Tul., and the various preventive methods of treatment which had been tried.

Prof. T. Wibberley gave an account of his experiments on "Intensive Corn-Growing" in Ireland which he has been carrying on for the past ten years. He advocated the sowing of oats very early, immediately after the ground was cleared of the first crop; at the end of September the crop was cut several times or grazed, and then manured in the spring. In this way it was claimed that heavier crops could be grown without danger of their being laid.

An important paper on "The Artificial Production of Vigorous Trees by Hybridisation" was read by Prof. A. Henry; the full paper has since been published in the *Quarterly Journal of Forestry* (vol. xiv., 1920, p. 253).

The joint discussion with the Botanical Section on "Plant and Soil Survey Work" brought forward an interesting group of papers on both the chemical and botanical sides. Mr. G. W. Robinson (Bangor) described the results of his soil survey work in North Wales, and showed that attempts to classify the soils according to the geological formation from which they were derived had proved unsatisfactory. This was partly due to large areas having been obscured by glacial drifts, and also to the fact that, even in the case of soils derived from the underlying rock, the variety of soil-types is by no means so great as that of rock types.

The soils have been classified into twelve types, four of which are composed of soils mainly derived *in situ* from the underlying rock, while the other types include transported soils such as drifts and alluvia.

Mr. E. A. Fisher dealt with the important question of soil acidity, and suggested doubts as to the trustworthiness of the ordinary methods for determining the "lime requirements" of a soil.

Prof. R. G. Stapledon described his "Surveys of Grassland Districts"; while Miss W. H. Wortham gave a summary of the results of a botanical survey of North Carnarvonshire and Anglesey.

Sir Daniel Hall, Messrs. C. G. T. Morison, T. J. Jenkin, C. T. Gimmingham, and R. Alun Roberts, Miss E. N. Miles-Thomas, and others took part in the discussion which followed. Sir Daniel Hall said that there did not always appear to be a clear conception as to the object of the work. He suggested the simplification of methods, if possible, and a closer attention to the economic side of the question.

From the discussion two points emerged: (1) The soil chemists were quite agreed that the time had come for a revision of the methods of soil sampling and analysis at present in use, and it was felt that it was not desirable to embark on any extensive new work before this was done. (2) It was evident that there was need for a much closer co-operation between the soil chemist and the plant ecologist, both in planning survey work and in carrying it out. This is more true of England than of Scotland.

It was resolved to appoint a joint committee representing plant ecologists and soil chemists to consider and report on the whole question.

At the closing meeting Mr. G. S. Robertson described the results of his most recent investigations on manuring with ground rock-phosphates. He referred to the increasing demand for phosphates both at home and abroad and to the difficulty of maintaining the supply of superphosphates and slag. The experiments showed that ground mineral phosphates gave results which compared very favourably with the returns given by the old basic Bessemer slags.

Amongst the other papers read were "Experiments on Green Manuring," by H. J. Page; "The Sugar-Content of Straw," by S. Hoare Collins; and "The Varieties of Oats," by C. B. V. Marquand.

ALEXANDER LAUDER.

Studies of Heredity.

MR. C. C. LITTLE has studied (*Journal of Genetics*, vol. viii., 1919, pp. 279–90) colour inheritance in cats, with special reference to black, yellow, and tortoiseshell, and gives an explanation—not a very easy one—of the rare occurrence of tortoiseshell males which may be either sterile or fertile. The genetic constitution of the normal colour varieties of cats as regards yellow and black pigmentation appears to be as follows: B=a factor producing black pigmentation, Y=a factor which restricts black from the coat, and *y*=a factor allelomorphic to Y and hypostatic to it, allowing black pigment to extend to the coat. Mr. Little also discusses (*Science*, vol. li., 1920, pp. 467–68) a curious case in the Japanese waltzing mouse of hereditary susceptibility to a transplantable tumour. He concludes provisionally that from three to five factors—probably four—are involved in determining susceptibility to the mouse sarcoma; that for susceptibility the simultaneous presence of these factors is necessary; that none of these factors is carried in the sex (x) chromosome; and that these factors Mendelise independently of one another. In another paper (*Amer. Naturalist*, vol. liv., 1920, pp. 267–70) the same investigator criticises Dunn's suggestion that there is a linkage between the genes for yellow and for black in mice, and shows that the facts may be explained by assuming that yellow, when present, hampers the action of a lethal factor in much the same sort of way that it hampers the activity of the black-forming factor in the skin and hair. In a note on "Some Factors Influencing the Human Sex-Ratio" (Proc. Soc. Exper. Biol. and Medicine, vol. xvi., 1919, pp. 127–30) Mr. Little concludes: (1) That a significant excess of males is observed in the progeny of human matings involving racial crosses as compared with matings within the race; (2) that racial crosses between the European races studied (Italian and Spanish) will produce in the first hybrid generation a significant excess of males (which will be economically important to the United States); and (3) that there are significantly fewer stillbirths among the progeny of the hybrid matings studied than among the pure matings. In another paper (*Amer. Naturalist*, vol. liv., 1920, pp. 162–75) Mr. Little deals with exceptional colour-classes in doves and canaries. These have been explained on the hypotheses of "partial sex-linkage" and "non-disjunction," but the author thinks it is more legitimate to suppose a factorial change from one gene to its allelomorph, perhaps as the effect of "intergenic and intra-cellular environment." In a note on the origin of piebald spotting in dogs (*Journal of Heredity*, vol. xi., 1920, pp. 1–4, 3 figs.) Mr. Little deals with two cases in dogs which give direct evidence as to the origin of spotted individuals, and suggests that a spotted race may arise from a self-race, by mutation, without passing through a series of minute gradations directed by selection.

Dr. C. B. Davenport (Proc. Nat. Acad. Science, vol. iv., pp. 213–14) deals with an hereditary tendency to form nerve-tumours (multiple neurofibromatosis). Proliferations of the connective tissue-sheaths of nerves result in numerous sessile or pedunculate swellings. The course of the disease, which is rare, is influenced by metabolic changes in the body. There is sometimes an associated production of pigmented spots in the skin. There is evidence that the disease may occur in successive generations, and that it behaves as if it were a dominant, occurring in about 50 per cent. of each affected fraternity. "The fact that neurofibromata have an inheritable basis strengthens the view that cancers in general have such a basis." In another paper (*Journal of Heredity*, vol. x., 1919, pp. 382–84) Dr. Davenport reports a case of a Cleveland family where a tendency to multiple births has appeared in each of four successive generations. We have also received Dr. Davenport's annual report as director of the department of experimental evolution and of the eugenics record office of the Carnegie Institution of Washington. It gives us a glimpse of a manifold activity. Investigations are in progress on the modifiability of the germ-plasm by alcohol, the control of sex in pigeons, the sex-intergrades in Daphnia, the heredity of colour in dogs, cats, doves, and canaries, heredity in aristogenic families, inbreeding in man, and many other subjects.

The Pan-Pacific Scientific Conference.

THE first meeting of the Pan-Pacific Scientific Conference was held at Honolulu on August 2–20. At the close of the meeting a number of general resolutions were passed which concerned the conference as a whole. It was resolved that similar conferences should be held at intervals of not more than three years, and that the Governor of Hawaii should be invited to take action to make the conference a permanent organisation. Other resolutions dealt with the desirability of establishing an International Research Council, and with the need for the equipment of ships by the Governments concerned for the purpose of carrying out scientific research in the Pacific Ocean. The last general resolution was concerned with the promotion of education and with the need for the better payment of scientific workers; this was dealt with more fully in NATURE of October 21, p. 249.

The sections of the meeting have also published a number of recommendations. The section of anthropology advocates measures which are similar to those urged by Prof. Karl Pearson in his presidential address to Section H (Anthropology) of the British Association at the meeting this year at Cardiff. It recommends that centres for study and research in anthropology should be developed by the expansion of university departments or by the alliance of universities with other research institutions, so that such schools may combine all the features of museums and of research and teaching institutions. Research is particularly necessary into the history and culture of the Polynesians in order to reach a satisfactory solution of the ethnological problems of the Pacific.

The resolutions of the section of biological science can be divided into three groups; the first deals entirely with marine biological survey in the Pacific. It is contended that the work should be undertaken by the Governments of those countries bordering on the Pacific Ocean, and that steps should be taken to avoid the overlapping of work which might otherwise occur. The second group of recommendations deals with the land fauna of the Pacific islands. A survey of the fauna, and particularly of the mollusca, on both the better-known and the comparatively unknown islands in the Pacific is advocated. The last group of recommendations deals with the flora of Polynesia. Surveys are again necessary, and attention is directed to the importance of investigating carefully the flora of new lava-flows.

Surveys are also the burden of the recommendations of the geographical section. Topographical maps of many land areas in the Pacific are incomplete, and surveys of the shore-line and coastal waters are necessary. Continued work is also necessary in order to complete the general magnetic survey of the Pacific Ocean, and to extend this work to coastal waters where the magnetic phenomena are known to be complex. Recommendations dealing with physical oceanography merely emphasise those put forward by the biological section when referring to marine biology; the two ends could be served by the same expedition. Meteorology is also included in the scope of the section on geography. Observation at the place of origin of typhoons, cyclones, etc., and of the motion of these disturbances is necessary, and the establishment of an observatory on the Island of Hawaii and the resumption of observations at Macquarie Island are advocated. In most cases it is urged, on the plea of expense, that the work should be undertaken by the States bordering on the Pacific.

The section dealing with geology passed a number of resolutions advocating extensive geological surveys in the Pacific area. It recommends that three maps on the international scale of 1 : 1,000,000 should be drawn, one showing topographical features, another geological formations, and the third mineral resources. Another important group of recommendations deals with the importance of subaerial and submarine erosion, and asserts the need for research on the geological side of these matters. A plea was also made for the planning of research in such a way as to correlate the efforts of different workers and to promote a uniform mode of publication of results.

Three motives, the need for localised work, for publication and for the education of people in providing safeguards against disaster, and for precise geophysics, were the basis of the resolutions passed by the section on seismology and vulcanology. The section recommends the establishment of more volcano observatories, and also the intensive study of earthquakes in seismic provinces as likely to lead to advances in geophysical knowledge. It also advocates that complete statistics of earthquakes and eruptions for the whole world should be compiled. This project could be furthered by the establishment of a central bureau for the Pacific which could collect and disseminate information of a seismological nature, and later the same scheme could be applied to the world. An important resolution was that dealing with the training of people in proper methods of construction and in behaviour during emergencies in countries liable to seismic disaster.

Polynesia is to be congratulated on having successfully gathered together her men of science in an endeavour to increase our knowledge of the Pacific Ocean and of the conditions existing in the archipelagoes of that side of the world.

Mathematics in Secondary Education.

BULLETIN No. 1 (1920), recently issued by the U.S. Bureau of Education, shows that the authorities at Washington are fully alive to the difficulty of the problems that confront the secondary schools in this era of reconstruction. It contains, under the heading "The Problem of Mathematics in Secondary Schools," a report of a committee which confesses at the outset that it has been unable to come to definitive conclusions. The committee has therefore contented itself with throwing out suggestions based upon an analysis of the existing situation in the hope that the result will be such a series of discussions and experiments as will enable future committees eventually to arrive at definite proposals for reconstruction.

At the outset the present state of affairs is acknowledged to be entirely unsatisfactory. Traditions are to go by the board, and the admission of a subject to the curriculum must be based upon its value in relation to the conditions of social welfare. Not only mathematics, but all subjects, are to be reviewed and revalued. The psychologist has come upon the scene. The uncritical belief of the past in "mental discipline" is challenged. The general recognition of individual differences and the growing practice of differentiation and adaptation afford additional reasons for a close examination of the usual courses, and side by side with this problem is that of the courses best adapted for average mortals and for those who will proceed to an advanced stage of study.

As for the method of presentation, the report emphatically condemns the old divorce from reality. The ideas and the interests of the pupils must be utilised as the environment in which the mathematical conception is to find its natural setting. The existence of the conception within the *milieu* provides the necessary stimulus for its utilisation. The ideas and interests of the pupil provide it with projects and problems to which it desires solutions. The instruments for this purpose are to be found in the concepts. The "instrumentally selected content" must be free of all that will destroy potential interest, and will make an end of the watertight compartments into which our subject has so long been divided. With this instrumental basis of selection and procedure it is possible for all to begin together. But the future specialist will already, as he proceeds, be more attracted than the average student by the mathematical relationships, and find pabulum for thought in the mathematical instrument itself and in the assumptions which in the earlier stages he has taken for granted as natural. The place for the fully developed logical system is not here as yet, nor will it be found in the work of the future engineer, who will be content with the mathematics which is required in the projects and problems of a preliminary engineering course.

Definition is likewise required of the demarcation between the practical and the cultural or "interpretative" use of mathematics, and here must also be defined the groups which require enough to meet their social demands and individual aptitudes. These groups must necessarily overlap. The content of the course in all cases must be decided by a preliminary study of the irreducible minimum, and that is obtained by the rigid exclusion of all material of which the specific value for the definite purpose cannot be fully shown. The proposals do not differ in any very marked degree from the conclusions of, say, the Committee of the Mathematical Association, which some years ago drew up a tentative course for average students and for future specialists. There is in this bulletin much that is worth quoting. Conditions of space limit us to the following passage, which, though it contains nothing new, is nevertheless very true, and its teaching cannot be too strongly impressed upon the minds of teachers, especially upon those of the young and enthusiastic.

"Teachers . . . only too frequently deceive themselves as to the place that the presentation of a rigorously logical proof plays in bringing conviction. The worth of a sense of logical cogency can hardly be overestimated; but we who teach not infrequently overreach ourselves in our zeal for it. The teacher of introductory mathematics can well take lessons from the laboratory, where careful measurement repeated under many different conditions will bring a conviction often otherwise unknown to the pupil who is not gifted in abstract thinking. Probably in most instances an inductively reached conviction is the best provocative of an appetite for a yet more thoroughgoing proof."

There is one further point that should be noticed: the resentment on the part of American secondary schools at the attempts of the colleges to dictate the contents of their courses. Any restriction placed upon the free play of discussion and experiment is strongly deprecated.

University and Educational Intelligence.

LONDON.—A lecture on "Some Considerations on Tonus and Reflexes" will be given at the Royal Society of Medicine (1 Wimpole Street, W.1) by Prof. J. K. A. Wertheim Salomonson, professor of neurology in the University of Amsterdam, at 5 p.m. on Monday, January 17. This lecture has been arranged under a scheme for the exchange of lecturers in medicine between England and Holland. Five other Dutch lecturers will also give one lecture each, particulars of which will be announced later. A course of eight lectures on "The Physiology of the Embryo, Fœtus, and Newly-born" will be given by Prof. M. S. Pembrey in the Physiological Theatre, Guy's Hospital, at 4.30 p.m. on Thursdays, January 13, 20, and 27, February 3, 10, 17, and 24, and March 3. Admission to these lectures is free, without ticket.

SIR LEONARD ROGERS has been appointed Stuart Mill lecturer in tropical medicine at the London (Royal Free Hospital) School of Medicine for Women, and Miss Dorothy Maughan lecturer in pharmacy.

IN connection with Somerville College, Oxford, a Mary Somerville research fellowship of the value of 250*l.* for three years will be offered in March next. Particulars may be obtained from Miss M. F. Moor, Old Headington, Oxford.

APPLICATIONS are invited by the Senate of the University of London for the Graham scholarship in pathology, value 400*l.* per annum for two years, and tenable at University College Hospital, Gower Street, W.C.1. Particulars are obtainable *personally* from the professor of pathology at the college. Applications for the scholarship must be sent to reach the Principal Officer, University of London, South Kensington, S.W.7, by the first post of Monday, January 17, 1921, marked "Graham Scholarship."

ON December 20 Mr. J. H. Gardiner, representing Messrs. James Powell and Sons (Whitefriars), Ltd., in company with Mr. P. Annett, divisional organising officer for the Middlesex Education Committee, made a visit to Greenhill, Drill Hall, and Harrow Weald Council Schools, and addressed the boys who, having reached the age of fourteen, were upon the point of leaving school. The object was to interest the boys in the glass industry and to suggest to them the possibilities of good employment in the glassworks that are now being erected at Wealdstone. The boys, having been told the character of the work and the prospects that it holds out to them to learn one of the most important trades in the country, were invited to attend a series of evening continuation classes during the coming term, when a syllabus has been arranged to give them a thorough grounding in English, arithmetic, the metric system, physical manipulation (woodwork, etc.), freehand drawing, and elementary chemistry and physics. After attending the classes a selection will be made of the most promising boys, who will then pass through a special course of technical lectures in glass, its chemistry and properties. After this they will be drafted into the works, where a special laboratory is being fitted up in which for a certain number of hours a day they will learn the rudiments of the many branches of the industry. During the remaining portion of the day they will be employed in making themselves useful in one or other of the many departments of the firm. The speed at which they will learn their business will depend upon their own efforts, aided by all the assistance that can be given to them in the way of instruction.

AN interesting pamphlet has been published by the Universities Bureau of the British Empire, 50 Russell Square, London, W.C.1, containing lists of the students and teachers from our Colonies and from foreign countries who are studying in or attached to the universities of Great Britain. It is a record of the large-scale hospitality which is extended by our centres of learning to students of all nationalities. India sends us by far the largest number of students; including those from Burma and Ceylon, there are as many as 665 Indian students at present being educated in this country, of whom 292 are at London University and 125 and 67 respectively at Cambridge and Oxford. South Africa sends a large contingent, which is divided among the same universities roughly in equal numbers. Canada and Australia also have students in Great Britain, of whom the greater number are at Oxford; the totals for these Dominions are 123 and 121 respectively. Of foreign countries the United States is the largest contributor; 329 students in all are over here, of which 193 are at Oxford, 68 at London, and the remainder are distributed between Cambridge and the provincial universities. The subjects which have the greatest attraction for both Colonial and foreign students appear to be economics and medicine. It is also interesting to note that there are 56 Serbian and 66 Russian students studying in our universities at the present time.

AT a recent meeting of the trustees of the General Education Board of the Rockefeller Foundation grants amounting to 20,251,000 dollars were made to ninety-eight colleges and universities for general education and for the development of medical schools. Of this sum 12,851,666 dollars will be given as an endowment to provide increases in teachers' salaries, provided that the institutions themselves succeed in raising for the same purpose a sum of 30,613,334 dollars. Medical schools will benefit to the following extent:—1,250,000 dollars for endowment and 70,000 dollars for additional laboratory facilities to Washington University Medical School, St. Louis; 1,000,000 dollars for the endowment funds of Yale Medical School; 300,000 dollars for improving the facilities in obstetrics and 350,000 dollars for the development of the teaching of psychiatry in Harvard Medical School; and 400,000 dollars for the development of a new department of pathology in the Johns Hopkins Medical School. For the furtherance of general medical research 1,000,000 dollars has been alloted to the Medical Research Foundation of Elizabeth, Queen of the Belgians, Brussels. Other grants were made for a number of educational purposes, 287,350 dollars for co-operation between State universities and State Departments of Education in the Southern States of America in the fields of secondary and rural education, and 500,000 dollars for endowment and 443,500 dollars for current expenses and equipment of negro schools. A grant of 15,000 dollars has also been made to the American Conference on Hospital Service for the purpose of establishing a library and a service bureau, and one of 25,000 dollars to the National Committee for Mental Hygiene (U.S.) to enable it to carry out surveys on the care and treatment of mental diseases during the year 1920.

Calendar of Scientific Pioneers.

January 1, 1748. John Bernoulli died.—Born at Basle in 1667, he shares with his brother James the credit of developing the infinitesimal calculus, their mastery of which was acknowledged by Leibniz.

January 1, 1817. Martin Heinrich Klaproth died.—The first chemist in Germany to adopt Lavoisier's views, he became in 1809 the first professor of chemistry in the newly created University of Berlin.

January 1, 1894. Heinrich Rudolf Hertz died.—Hertz, who was born in Hamburg, February 22, 1857, went to Berlin in 1878, and later became an assistant to Helmholtz. At Kiel in 1883 he studied Maxwell's work, and afterwards at Karlsruhe gave the first experimental verification of Maxwell's electromagnetic theory of light. The Hertzian waves used in wireless communication are of the same nature as those of light, but of much greater wave-length and with a wider range. Hertz died at the age of thirty-seven, soon after he had discovered how to produce and detect these waves, but the later development of wireless signalling is based upon his fundamental work.

January 2, 1816. Louis Bernard Guyton de Morveau died.—By profession a lawyer, Morveau devoted his leisure to chemistry, and in 1787, with Fourcroy, Berthollet, and Lavoisier, published the important work "Méthode de Nomenclature Chimique."

January 3, 1640/41. Jeremiah Horrocks died.—While a curate at Hoole, in Lancashire, Horrocks at the age of twenty-two calculated and observed for the first time a transit of Venus. This he saw on November 24, 1639. Within fourteen months of his great achievement he died suddenly at Toxteth. The interest aroused by the transit of 1874 led to a memorial to Horrocks being placed in Westminster Abbey in 1879.

January 3, 1908. Charles Augustus Young died.—One of the most energetic of American astronomers, especially in spectroscopic work.

January 4, 1882. John William Draper died.—Chemist, physiologist, and historical and philosophical writer, Draper obtained in 1839 the first portrait by the daguerreotype process, and in 1840 the first photograph of the moon. Born near Liverpool on May 5, 1811, he emigrated to America, and assisted to found, and served as president of, the New York Medical School. His "History of the Intellectual Development of Europe" appeared in 1862. Henry Draper (1837–82), the astronomer, was his son.

January 4, 1906. Charles Jasper Joly died.—Born at Tullamore in 1864, Joly in 1897 became Astronomer-Royal of Ireland.

January 5, 1904. Karl Alfred von Zittel died.—Educated at Heidelberg, Paris, and Vienna, in 1863, when twenty-four, Zittel became professor of mineralogy at Karlsruhe, and three years later succeeded Oppel at Munich. Widely known for his writings, such as his "Handbook of Palæontology" and his "History of Geology and Palæontology to the End of the Nineteenth Century," he was president of the Royal Bavarian Academy of Sciences and a Wollaston medallist of the Geological Society.

January 5, 1913. Louis Paul Cailletet died.—A student at the Paris School of Mines, Cailletet's first researches related to metallurgy. Later work led him to study gases under pressure, and in 1877 he succeeded in liquefying oxygen. A like result was obtained at about the same time by Pictet at Geneva. Cailletet, who was a member of the Paris Academy of Sciences, was in 1910, at his academic jubilee, referred to as "the father of modern cryogenics."

E. C. S.

Societies and Academies.

PARIS.

Academy of Sciences, December 6.—M. Henri Deslandres in the chair.—G. **Lemoine**: The mutual reaction of oxalic and iodic acids: the influence of heat and dilution. Oxalic acid in aqueous solution is slowly oxidised by iodic acid to carbon dioxide, iodine being set free. The reaction is a slow one and well suited for the study of its velocity. Diagrams of the effects of dilution and temperature are given.—P. **Termier** and W. **Kilian**: The overlapping fragment at Mont Jovet (Tarentaise): the glistening schists to the north of Bourg-Saint-Maurice. This fragment is shown to have come neither from the north-west nor from the west; its probable origin is from the east or the south-east, and appears to have been carried from the Briançon layer.—A. **de Gramont**: Table of lines of high sensibility of the elements, arranged for analytical work. A table of wave-lengths for use in the spectroscopical detection of the elements in analytical work. The most prominent and the most persistent lines are given, both for eye observation and for photography with uviol and with quartz prisms.—M. **Laubeuf**: The application of the Pitot tube to the measurement of the velocity of ships. M. Mesnager has recently commented on a note on this subject by the late M. Yves Delage. A note on the same subject was communicated to the Academy so far back as 1901 by MM. Raverot and Belly, and the apparatus there described has been tested on three French ships. It was found to be impossible to correct on theoretical grounds for the numerous sources of error, and the instrument had to be calibrated by running over measured distances and drawing a curve giving the relations between the readings of the instrument and the actual velocities.—G. **Dumas** and J. **Chuard**: The homologies of Poincaré.—P. **Humbert**: Laplace's equation in hypertoroidal co-ordinates.—A. **Egnell**: Congruences of right lines the mean surface of which is a given surface.—B. **de Fontviolant**: Calculation of the strengths of bridges.—J. **Guillaume**: Observations of the sun made at the Lyons Observatory during the third quarter of 1920. The observations made on eighty-one days during the quarter are classified in three tables, showing the number of spots, the distribution of the spots in latitude, and the distribution of the faculæ in latitude.—A. **Danjon**: A relation between the light of the eclipsed moon and solar activity. The luminosity of the eclipsed moon is known to vary. Adopting a scale of 5° of brightness, this has been plotted against the date of the eclipse. The resulting curve rises from one solar minimum to the next, with a sudden fall at each minimum. The passage through a maximum of solar activity is marked by no peculiarity.—P. **Menard**: A reversible mercury manometer with damped oscillations.—A. **Pérard**: The interference method for the determination of quartz standards of length. A description of the modified Michelson method employed, in which any silvering of the surfaces of the standard is avoided, and a table showing the refractive indices of two standards for wave-lengths between 435·8 $\mu\mu$ and 643·8 $\mu\mu$.—G. **Ribaud**: Wide continuous absorption bands of light.—L. **de Broglie**: The absorption of the Röntgen rays by matter.—F. **Brocq**: A general method of continuous electrical integration.—A. **Damiens**: The subiodide of tellurium, TeI_2. Contribution to the study of the system iodine–tellurium. A curve of the melting points of mixtures of iodine and tellurium is given. The only definite compound appears to be TeI_4; no substance TeI_2 exists, the mixture having that composition being a mixture of the tetraiodide and a solid solution of tellurium and tetra-iodide. Both thermal and metallographic analyses lead to the same conclusion.—M. **Barlot**: A complex combination of thallium and hydrofluoric acid. The double fluoride H_2TlF_3 has been isolated. The thallium can be precipitated by the usual reagents, but the solution gives no precipitate with the usual reagents, such as calcium salts, and does not attack glass, although strongly acid to indicators.—M. **Geloso**: The reduction of permanganate by arsenious acid.—G. **Mignonac**: The catalytic hydrogenation of hydrobenzamide. Method for the preparation of benzylamine. From a study of the reduction of hydrobenzamide in alcoholic solution by hydrogen in presence of nickel, it would appear that the addition product described by O. Fischer is not formed; the products are benzylamine, benzalbenzylamine, and ammonia.—P. **Robin**: The oxidation of arisaldoxim: the peroxide of arisaldoxim.—A. **Mailhe** and F. **de Godon**: The preparation of the methyl derivatives of the xylidines and naphthylamines by catalysis.—L. **Bertrand**: The mode of formation of the Pyrenean strata.—F. **Gomez-Llucea**: The geology of Cabrera, Conejera, and other neighbouring islands.—P. T. **de Chardin**: The succession of the mammalian fauna in the lower European Eocene.—H. **Joly** and N. **Laux**: The fauna of the lower layers of the Aalenian of the Grand Duchy of Luxembourg.—A. **Boutaric**: The variation of nocturnal radiation during clear nights. The intensity of the nocturnal radiation during clear nights passes through a maximum shortly after sunset, and then decreases slowly and regularly until dawn.—H. **Courtonne**: The opposed action of soluble chlorides and sulphates on starchy materials. A saturated solution of magnesium chloride rapidly and completely converts, in the cold, starchy matter into soluble starch. Magnesium sulphate exerts a contrary action and prevents the formation of soluble starch in solutions heated in closed vessels to 115° C.—W. **Kopaczewski**: The mechanism of the Bordet-Wassermann reaction.—A. **Lumière** and H. **Couturier**: The shock produced by the introduction of insoluble substances into the circulation. The injection of barium sulphate suspended in an artificial isotonic serum into the carotid of a dog caused the typical symptoms of anaphylactic shock.—A. **Bach** and B. **Sbarsky**: The estimation of the degradation products of proteid materials in blood serum. The reducing ferment of milk may be utilised for the detection and estimation of small quantities of degradation products of proteids.—MM. **Desgrez**, **Guillemard**, and **Savès**: The purification of air contaminated with certain toxic gases. A solution containing sodium sulphide and soap when used in the form of a fine spray has been found to be capable of removing chloropicrin, chlorine, phosgene, methyl chloroformates, acrolein, bromoacetone, cyanogen chloride, and benzyl iodide, bromide, and chloride. Various mixtures were tried, but none proved to be capable of such general application as the above.—M. **Kohn-Abrest**: General method for the detection and estimation of arsenic.

SYDNEY.

Royal Society of New South Wales, November 3.—Mr. James Nangle, president, in the chair.—J. H. **Maiden**: A new Angophora. A mallee-like species recorded so far from Northbridge on the north, and from Kogarah on the south, of Port Jackson. It has been passed over as a petiolate- and more lanceolate-leaved form of *A. cordifolia*, DC., but it is smaller in all its parts, less hispid, the inflorescence less corymbose, and with the differences between the juvenile and mature leaves more accentuated.—J. H. **Maiden**: Three new species of Eucalyptus. The author has previously expressed the opinion that important results are awaiting those who more thoroughly investigate trees attributed to existing forms instead of giving too much attention to the search for rare and bizarre forms. This paper directly illustrates this point, and the following New South Wales trees are proposed as new. All yield valuable timbers:—(*a*) The Blue Mountains mahogany, attributed without doubt to *Eucalyptus resinifera*, Benth., for so many years, has pale-coloured, fissile timber very sharply different from that species. (*b*) The tall grey gum of the counties of Gloucester and Durham, hitherto named *E. punctata*, var. *grandiflora*, and therefore assumed to have a deep red timber, turns out to have pale-coloured, tough timber allied to that of the spotted gum (*E. maculata*, Hook.). (*c*) Less was known of this tree, the type of which comes from Wyee, north of Gosford. It is a grey gum with a deep red-coloured timber, possessing botanical characters intermediate between *E. longifolia*, Link and Otto (woolly-butt), and *E. punctata*, DC., the best known of our grey gums.—L. A. **Cotton** and Miss M. **Peart**: The calculation of the refractive index in random sections of minerals. The method employed is a graphical one, in which use is made of the stereographic projection. Both refractive indices for any given mineral section can be calculated when the form and position of the indicatrix are known. The principle is simple, and has been applied by Miss Peart to the evaluation of the refractive indices of the plagioclase felspars for cleavage flakes parallel to the (010) and (001) crystallographic forms.

Washington, D.C.

National Academy of Sciences (Proceedings, vol. vi., No. 4), April, 1920.—N. L. **Bowen**: Differentiation by deformation. The deformation of an igneous mass during crystallisation, with consequent separation of liquid from crystals, has frequently been suggested as a cause of variation of igneous rocks, and this suggestion is here discussed in considerable detail under the headings of discontinuous differentiation, monomineralic types as members of composite intrusives, monomineralic types as simple "intrusives," complementary dykes, primary banding, and alkaline rocks. —T. H. **Morgan**, A. H. **Sturtevant**, and C. B. **Bridges**: The evidence for the linear order of the genes.—C. W. **Metz**: The arrangement of genes in *Drosophila virilis*. Two papers in continuation of the discussion of the linear *versus* spatial arrangement of the genes.—G. W. **Stewart**: The functions of intensity and phase in the binaural location of pure tones. With frequencies of 100 to 1200 d.v., phase is the chief factor in localisation with pure tones, the intensity effect being practically *nil*, or at least very small.—L. T. E. **Thompson**, C. N. **Hickman**, and N. **Riffolt**: The measurement of small time-intervals and some applications, principally ballistic. A description of a new apparatus for indicating very small intervals of time with application to the ballistics of small arms.—H. H. **Sheldon**: Charcoal activation. The variations due to heat treatment may be explained by assuming that the structure of the charcoal is modified or that the air was the agent causing the variations. Data are given and interpreted on the basis of the latter assumption.—J. K. **Whittemore**: The starting of a ship. A discussion with simple integral equations of the problem of a particle moving under the action of tangential forces dependent on the velocity alone, with suggested applications to marine engineering and to the study of the laws of liquid resistance.—F. L. **Hitchcock**: A thermodynamic study of electrolytic solutions. The adoption of Gibbs's principle of chemical potential leads to the extension of the ordinary theories of melting point, heat potential, and mass law. These extensions are the result of the presence in the expression of the chemical potential of the solvent for the terms in the second and higher powers of the concentrations.—I. W. **Bailey**: The formation of the cell-plate in the cambium of the higher plants. Continuation of a previous paper indicating that the type of cell-plate formation there described is of frequent occurrence, and promises to be significant in any general discussion concerning the dynamics of cytokinesis and karyokinesis.—I. A. **Barnett**: Functionals invariant under one-parameter continuous groups of transformations in the space of continuous functions. Examples of one-parameter continuous groups are given, with in each case a functional invariant in terms of which each invariant of the group is expressible.—H. **Shapley**: Thermokinetics of *Liometopum apiculatum*, Mayr. A curve is obtained relating the speed of these ants to the temperature. The speed is less erratic at higher temperatures, and increases over a 30° C. range from 0·44 cm. to 6·60 cm. per second.—J. **Loeb**: The influence of ions on the osmotic pressure of solutions. A summary and discussion of an extensive series of experiments. At lower concentrations of the electrolyte the influence of the anion increases more rapidly with increasing concentration of the electrolyte than the depressing effect of the cation, while at higher concentrations the reverse occurs. The turning point lies for a number of electrolytes at a molecular concentration of about $m/256$.—D. H. **Tennent**: Evidence on the nature of nuclear activity. The basophilic bodies are not in the nature of chromidia, but are the result of indirect nuclear activity. The explanation offered for the formation of the basophilic extra-nuclear bodies described is intended to be suggestive rather than conclusive.—A. C. **Hardy**: A study of the persistence of vision. Measurement of the persistence of vision for several colours within a cone the semi-vertical angle of which is about 40°.—R. **Pearl**: A contribution of genetics to the practical breeding of dairy cattle. A summary of investigations extending over many years with respect to the value of 224 Jersey Registry of Merit sires in relation to their transmitting qualities in milk-production. This work gives the breeder information of a sort that he has never had before, and that enables him at once to form a real judgment of the worth of various bulls which appear in the pedigree of Jersey cattle.

(Proceedings, vol. vi., No. 5), May, 1920.—H. H. **Laughlin**: Calculating ancestral influence in man. The problem is that of measuring ancestral influence by tracing chromosomes. By applying principles of combination and chance, the probability that a given complex situation will result from a given set of constituent conditions may be formulated mathematically. The formulæ here given are foundational, and are stated in general terms the validity of which depends upon their presenting correct mathematical pictures of chromosomal processes which work out in the germ-cell cycle.—G. **Medes** and J. F. **McClendon**: The effect of anæsthetics on living cells. An attempt to determine the effect of different anæsthetics on several activities or properties of living cells. Not all anæsthetics had the same effect, and the same anæsthetic affected the same activity of a plant differently from an animal, and different activities of the same cell differently. All the anæsthetics tried increased plant-cell respiration and permeability.—R. A. **Daly**: A general sinking of sea-level in recent times. The facts at hand seem to permit belief in the synchrony of the different strand-markings and emergences here considered, but further investigation is needed.—C. C. **Little**: A note on the human sex ratio. A brief study of data collected at the Sloane Maternity Hospital in New York City.—O. **Blackwood**: The existence of homogeneous groups of large ions. It is found that for ionisation from spray and from hot wires the gradation in the size of the ions is continuous, as the mobility curves do not show sharp, separated peaks. The conclusion favours the hypothesis of Sir J. J. Thomson.—E. J. **Cohn**: The relation between the isoelectric point of a globulin and its solubility and acid-combining capacity in salt solution. A detailed discussion of the effect of sodium chloride upon the solubility of tuberin and the effect upon its acid-combining capacity.—H. P. **Armsby**, J. A. **Fries**, and W. W. **Braman**: The carbon dioxide: heat ratio in cattle. Within a range of 5 to 27 grams of feed per kg. live-weight a simple equation may be used for computing the (CO_2: heat) ratio when the live-weight and the amount of feed consumed are known. Thus the heat production may be computed from the observed CO_2 production.—H. S. **Vandiver**: Kummer's memoir of 1857 concerning Fermat's last theorem. It is shown that the proofs given by Kummer are inaccurate and incomplete in several respects.—D. L. **Webster**: An improved form of high-tension direct-current apparatus. A description of an improvement in apparatus previously described.—R. W. **Glazer**: The effect of the concentration of nitrates on the reducing powers of bacteria. A number of species of micro-organisms were tested in Witte's peptone media containing various molecular concentrations of $NaNO_3$ and KNO_3.

Books Received.

The National Physical Laboratory. Collected Researches. Vol. xiv., 1920. Pp. iv+308+plates. (London: H.M. Stationery Office.) 25s. net.

Annual Report of the Board of Regents of the Smithsonian Institution, Showing the Operations, Expenditure, and Condition of the Institution for the Year ending June 30, 1918. (Publication 2549.) Pp. xii+612+plates. (Washington: Government Printing Office.)

Smithsonian Institution. United States National Museum. Bulletin 109. Contributions to a History of American State Geological and Natural History Surveys. Edited by G. P. Merrill. Pp. xviii+549+37 plates. (Washington: Government Printing Office.)

Smithsonian Miscellaneous Collections. Vol. lxxi., No. 1. Smithsonian Physical Tables. (Publication 2530.) Seventh revised edition prepared by F. E. Fowle. Pp. xlvi+450. (Washington: Smithsonian Institution.)

Diary of Societies.

SATURDAY, JANUARY 1.

ANNUAL CONFERENCE OF EDUCATIONAL ASSOCIATIONS (at University College, Gower Street), at 10.30 a.m.—A Joint Conference on The Use of Psycho-analysis in Education.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. J. Arthur Thomson: The Haunts of Life: The Open Sea (Juvenile Lectures).

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—Lecture.

MONDAY, JANUARY 3.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.30.—F. Kingdon Ward: The Travels of a Plant-Collector on the Borders of China (Christmas Lecture).

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Discussion: Professional Questions.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street), at 8.—C. A. Richardson: The New Materialism.

SOCIETY OF CHEMICAL INDUSTRY (at Chemical Society), at 8.—G. H. Thurston: The Smith Continuous System of Carbonisation.—Dr. I. Masson and T. L. McEwan: (1) The Recovery of Solvent Vapours from Air. Part I., The Use of Cresol for Ether-Alcohol; Part II., The Use of Sulphuric Acid for Ether-Alcohol. (2) The Analysis of Liquid and Gaseous Mixtures of Ether, Alcohol, and Water.

TUESDAY, JANUARY 4.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. J. Arthur Thomson: The Haunts of Life: The Great Deeps (Juvenile Lectures).

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—N. E. Luboshez: The Results of the Demonstration of Portraiture by Artificial Light of October 5, 1920.

MATHEMATICAL ASSOCIATION (Annual Meeting) (at London Day Training College).—Prof. A. S. Eddington: Relativity.—Dr. S. Brodetsky: Aeroplane Mathematics.—The Rev. S. H. Clarke: The Teaching of Mathematics to Boys whose Chief Interests are Non-Mathematical.—Prof. E. T. Whittaker: Some Unsolved Questions and Topics for Research.—Miss E. M. Read: Results of Visits Paid to Lycées of Paris and other Centres, and the Study of Education there, particularly from the point of view of Mathematics.

THE ASSOCIATION OF SCIENCE TEACHERS (at University College).—Miss M. B. Thomas: Presidential Address.—Dr. J. C. Drummond: Vitamines.

WEDNESDAY, JANUARY 5.

ROYAL SOCIETY OF ARTS, at 3.

PHYSICAL SOCIETY AND OPTICAL SOCIETY'S EXHIBITION (at Imperial College of Science), from 3 to 10. At 4.—Sir W. H. Bragg: Sounds in Nature. At 8.—Prof. A. Barr: The Optophone.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. S. H. Reynolds: The Lithological Succession of the Carboniferous Limestone (Avonian) in the Avon Section at Clifton.—Miss E. Bolton: The Carboniferous Limestone of the Wickwar-Chipping Sodbury Area (Gloucestershire).

THURSDAY, JANUARY 6.

ROYAL SOCIETY OF ARTS, at 3.—Sir Frederick Bridge: The Cries of London which Children heard in Shakespeare's Time (Juvenile Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. J. Arthur Thomson: The Haunts of Life: The Freshwaters (Juvenile Lectures).

PHYSICAL SOCIETY AND OPTICAL SOCIETY'S EXHIBITION (at Imperial College of Science), from 3 to 10. At 4.—Prof. A. Barr: The Optophone. At 8.—C. R. Darling: Some Unusual Surface Tension Phenomena.

FRIDAY, JANUARY 7.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.30.—Lt.-Col. C. Smith: Life on the Gilgit Frontier (Christmas Lecture).

SATURDAY, JANUARY 8.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. J. Arthur Thomson: The Haunts of Life: The Conquest of the Land (Juvenile Lectures).

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NATURE

THURSDAY, JANUARY 6, 1921.

Editorial and Publishing Offices:
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The Cost of Education.

THERE has just been issued the Seventh Report of the Select Committee on National Expenditure, a document, including appendices, of twenty-three folio pages, sixteen of which are devoted to the expenditure on public education, a subject which receives caustic criticism. It would appear that the net cost of education for the year 1920–21 for all forms of education from the public elementary school to the university throughout the United Kingdom is estimated at the vast sum of 97,206,548*l.*, of which 60,081,831*l.* is derived from taxes and 37,124,717*l.* from rates. This figure is in striking contrast to that of less than ninety years ago, when the local authorities contributed nothing from the rates and the only grant from the Exchequer was one made for the first time in 1834 of 20,000*l.* in aid of school buildings and not of their maintenance. This was the measure of our indifference to the cause of public education, from which the nation has suffered irremediable loss; it enabled more progressive nations with a finer insight into things of real value to compete with us in all departments of civilised life and its varied activities, to our great disadvantage.

Undoubtedly in these strenuous times all possible economies in national and local expenditure ought sedulously to be promoted, but it would be a foolish, not to say a disastrous, policy to limit unduly the expenditure in the means and encouragement of public education, especially for the mass of the people. It is demonstrable that a large percentage of this mass is susceptible to the greatest advantages which can be offered to it of facilities for the highest available education that the country can give. The Education Act of 1918 and the zeal which prompted and sustained its promoters throughout the lengthy debates in Parliament is the subject of deprecation in the Report, chiefly on the ground of the large expense in which the nation would be involved in carrying out its provisions at the present difficult time. Surely it is forgotten that expenditure upon education, wisely directed, is, with this qualification, a truly productive effort which will repay the nation a hundredfold within a generation.

The strictures in which the Committee indulges indicate a lack of genuine sympathy with the vital claims of the people to the benefit of a longer continued means of education for their children. Their claims go much beyond the demand for the familiar "three R's"; they require that the best fruits of literature and science shall be brought within their reach. The Committee views with something like dismay "an enthusiasm for education" on the part of the Board of Education, to which Mr. Fisher replies that "a Board of Education which was not enthusiastic for the promotion of education would not deserve to exist." It makes suggestions having for their object the serious curtailment of expenditure under the Education Act of 1918; such, for example, as would involve the withholding of the proposed continuation schools, one of the most valuable features of the Act; the prolongation of the vicious half-time system which mainly prevails in the textile districts of East Lancashire and West Yorkshire; the stoppage of new developments in the building of schools, both elementary and secondary, in certain towns and rural areas—this last policy has already been largely adopted by the Board of Education during the last five years, having regard to the high prices of materials and of labour, yet, it must be admitted, to the detriment of educational progress—the limitation of means of medical treatment so vital to the welfare of the elementary-school child; and finally, among other important developments made possible by the Act, the curtailment of the means of higher education so essential to the progress and well-being of the nation—objects which are set forth so ably in the Report of the Adult Education Committee and by the Workers' Educational Association.

It must be acknowledged that since the conclusion of the war there has been a remarkable development in public opinion as to the importance and value of education. The demand for secondary education has increased enormously, and the claims for admission to technical colleges and universities have been almost too great for their resources in teaching staff and equipment. In the year 1913–14 the number of full-time university students in the British Isles was roughly 30,000, or about 6·5 per 10,000 of population. The figures available for the year 1918–19 show that the number of students had almost reached 40,000. The number of students per 10,000 of population had jumped to 8·6; almost one in every thousand was receiving university training.

There has been but slight consideration given in the Report of the Select Committee to the enormous rise in the cost of materials and equipment, especially in reference to the secondary schools and technical institutions, during and since the war, nor has sufficient weight been given to the necessary rise in the salaries of the teaching staff due to the increased cost of living. This item alone accounts for 21,000,000*l.* in the estimated expenditure. If the schools and the higher institutions of learning are to be staffed efficiently with well educated and trained men and women, adequate salaries and prospects, and an assured provision such as the Teachers (Superannuation) Act affords for the time when they are no longer capable of rendering effective service, must be offered.

Mr. Fisher in a recent interview shows conclusively with regard to the Report in question that there are adequate safeguards in respect of extravagant expenditure both on the part of the Board of Education and on that of the public represented by the ratepayer. The nation will be well advised to encourage by all the means in its power the desire which is so plainly manifest for a longer life in the schools and for the advantages of an efficient secondary and university education for those who are qualified, to receive it. Now that the war is over we are entering upon a serious and strenuous time, when all the trained brain power at our command will be needed to meet the competition which we shall assuredly be called upon to face, and after all, as Mr. Fisher truly said in the interview before alluded to, "a nation which can afford to spend 400 millions a year upon drink and 100 millions upon tobacco is not quite at the end of its resources."

Territory and Bird Behaviour.

Territory in Bird Life. By H. Eliot Howard. Pp. xiii + 308. (London: John Murray, 1920.) Price 21*s.* net.

ON the publication of his "British Warblers" (1907–14) Mr. H. Eliot Howard took rank as a naturalist of marked ability, as an observer who could be trusted, and as an interpreter well trained in scientific method, fertile in suggestion, cautious in application, and, above all, insistent on the importance of keeping in close touch with the evidence afforded by patient and systematic field-work. A salient outcome of his monograph was a re-grouping of the phenomena presented by birds in their breeding haunts around a concept of "territory." He has now marshalled the evidence in favour of this hypothesis in a work which neither the biologist nor the comparative psychologist can afford to neglect.

To grasp Mr. Howard's root idea, we must recall the familiar routine of a bird's behaviour—and it is clearly with behaviour that observation must primarily deal. There is an orderly sequence the biological value or utility of which is centred in race-maintenance. Within this we can readily distinguish successive phases which are contributory to the routine as a whole. In the life of the wide-range migrant there is departure from the south, arrival in England, settling down in some part of the country, mating, sexual union, nest-building, incubation, feeding and rearing of offspring, and then departure from the breeding quarters to the south. All this is familiar enough. But closer observation discloses other facts. The males arrive in advance of the females; each male settles down in a restricted area within which some bush or tree is thenceforth his headquarters; the extent of this area is determined by the range of flight in oft-repeated excursions from the headquarters, and constitutes the "territory," which varies in size according to the species; the male bird is intolerant of any intruder into this territory, especially of a male of his species, fights him, and drives him out; he sings with maximum vigour at headquarters before any female is in evidence; this expression in song makes an attractive impression on some hen bird when she arrives in migration from the south; she becomes his mate, lives with him within the territory, and helps to drive out intruders. Mating is consummated, a nest built, and a brood reared within the territory, which affords, in the main, sustenance to the family; and in due season they depart. Now, of course, the sexual act may be regarded as the pivot on which the whole system of behaviour turns. But Mr. Howard contends that, to change the metaphor, the territory is the scene of the drama between arrival and departure; that the territory is secured and defended and the outburst of song in evidence before the females arrive; and that the size of the territory is such as to meet the requirements of the future. He holds, then, that the territory, if not the pivot in which the cycle of behaviour is centred, is the hook of biological utility on which it is hung.

Now, with regard to any routine of behaviour or phase therein, four questions arise: (1) In respect of the behaviour itself, is it unlearnt, or is it acquired in the course of individual experience? (2) Under what conditions of external stimulation does it come? (3) What is the good of it—its biological value? and (4) On what, in the constitution of the bird, does it depend? To the first three questions observational evidence affords the data for a reply. The answer to the last is in large measure a matter of inference.

As to the first, Mr. Howard is quite clear that, on the evidence, much of the behaviour involved in territorial routine is in form unlearnt. In so far as it is unlearnt, it is instinctive. This does not mean that the constituent details, as the matter incorporated in the behaviour as a whole, are purely instinctive. They are obviously in large measure learnt. Skill in their performance has been acquired. It means that the male bird in his first year occupies and protects the territory, and acts therein in specific ways, without having learnt by previous experience this *form* of behaviour-routine as a whole. Secondly, the external stimulation is, in Mr. Howard's opinion, afforded by the territorial situation, and not, in the early stage, by the presence of a female. To drive away an intruder involves, of course, the stimulus of his presence; it is, however, within the territory that the occupant attacks him; elsewhere, beyond its confines, the behaviour is no longer the same. The territory is, therefore, a feature of the situation that counts. Thirdly, it is clear enough, on the evidence, that the procedure has biological value. But—and this is of prime importance—Mr. Howard does not regard the prospective value of instinctive behaviour as implying the presence in mind of an end for the sake of which the bird acts. The biological value of securing a territory is the mating which follows in due course. *We* expect this outcome because we have knowledge of routine based on observation. But if the male in his first year has never mated, he cannot, on the basis of individually won experience, foresee this mating and what follows thereon. It is not for him an end to be attained by his behaviour. This is important—nay, essential—to the interpretation offered. For if there be inherited *knowledge*, the whole matter is easily explained as due to ancestral experience transmitted through "memory" to the bird that behaves under its guidance.

We come, then, to the fourth question: On what, in the constitution of the bird, does the behaviour depend? Mr. Howard refers to physiological changes in the organism which are correlated with tendencies to act in just that way which is open to observation in the unlearnt behaviour. This is what we speak of in a broad and general way as the nature of the bird. But this nature, and the correlated psychical nature, is different on different occasions. It is also attuned to the circumstances at the time, and gives to the behaviour much of its biological value. Such an attunement of the nature Mr. Howard calls a disposition. It is a state of physiological and psychical preparedness to act appropriately when the requisite stimulation is afforded. At the moment of action it is focussed as impulse. Thus at least may be interpreted many of Mr. Howard's statements, though in others there seems to be little difference between disposition and impulse. He often speaks of the disposition or the impulse as being "rendered susceptible to stimulation." For example, the territorial situation renders the impulse to drive away intruders susceptible. Some might prefer to speak of the susceptibility of *the bird* when it is in such a state as to respond to these or those external conditions. We thus avoid the risk of hypostatising a disposition or "an instinct." The essential point, however, is that the disposition that is inferred from the performance of unlearnt acts has factors which are congenital, and do not depend on individually won experience.

Brief illustration may here be given of changes of disposition. During the winter, before the mating season, lapwings live together in flocks. The males are seemingly on the most friendly terms with each other. Just such minor squabbles occur as may give some savour to the life of enjoyment. The females are, for the males, just other birds in the flock, and are not viewed, so to speak, in the light of a disposition to mate. Then in due season come the changes which constitute *ad hoc* physiological and psychical preparedness. Now one male and now another leaves the flock and occupies a territory in the fields; and, once there, he is intolerant of other males, fighting with any intruder for all he is worth. With the physiological change (partly due to specific internal secretions contributed to the blood-stream) there is a complete psychical change in the dispositional attunement of the bird's nature. Substantially the same presentation afforded by another male is now linked with quite different modes of overt behaviour. No longer gregarious, he is a solitary occupant of a restricted domain, driving all other males away. Presently he is joined by a mate, and the normal routine of reproduction runs its course. But if a cold snap should come on, the separated males may reunite in a flock, and the male is then no longer intolerant of other males. The physiological state probably reverts to its winter poise, and with this is correlated a reversion to the previous psychical disposition. But it seems that when a male bird (lapwing or other) has secured a territory and is intolerant therein of all others save a mate, he sometimes returns for a while to the flock which occupies a neutral area. *There* he is no longer intolerant of others, but moves among them on quite friendly terms. Hence in different circumstances, (1) in his territory and (2) in the flock, his disposition is different, so that occupancy of a territory appears to be a determining condition of the behaviour observed therein. If this sort of thing occurred in so marked a form in human life, it would perhaps be attributed to "dissociation," and described as an instance of double personality, two "streams of consciousness" being separated as if by a barrier. In any case, just thus, it seems, does the male bird in his first year behave, though he has never so behaved before, or seen others so behave.

Exigencies of space preclude more than an outline sketch of Mr. Howard's main thesis. The treatment in detail is admirable in its method of raising and meeting difficulties with no attempt to shirk them. The way in which the expression of song may produce a different impression on others at different times and in different circumstances is dealt with suggestively. All may not agree with Mr. Howard's conclusions; but all will admit the transparent candour of a genuine seeker after truth. One would like to comment on his contribution to the solution of the difficult problem of migration—turning upon the alternating interplay between the territorial and the gregarious poise in disposition. But lack of space forbids. The book is well written, well printed, and well illustrated, with photogravures from drawings by Mr. G. E. Lodge and Mr. H. Grönwold.

C. LL. M.

Airscrews in Design and Performance

Airscrews in Theory and Experiment. By A. Fage. Pp. ix+198+7 folding plates. (London: Constable and Co., Ltd., 1920.) Price 34s.

IT is difficult to place this book in the scheme of aeronautical progress, for it does not deal adequately with either the theory or the practice of airscrew design. The author has not succeeded in the idea expressed in the first sentence of his preface, where he says that "an endeavour has been made to present in this work an accurate and comprehensive account of the science of the airscrew from both its theoretical and experimental aspects." It is well known to all those connected with the experimental side of aeronautics that Mr. Fage, as a result of his position at the National Physical Laboratory, has had greater facilities for original work than any other British worker. The number of papers in his name which occur in the bibliography testifies to his activities, and the book cannot fail to have an importance in many directions. One would select chaps. v., vi., and vii.—that is, those dealing with experimental data —as justifying the writing of this book.

What is missed is the presentation of the results of research in a form which stimulates application to the workaday theories of the immediate future. Instead, one finds a very important recent development of theory compressed into one and a half pages of the book in such a way that, without prior knowledge, it conveys nothing to the reader. The basic theorem on which design rests comes from the conception that the several elements of an airscrew blade produce an airflow which is essentially of the same character as the flow round a wing. The application of this theory to aerial propellers is due to Drzewiecki and Lanchester, but after some little use and comparison with experiment it was found to be insufficiently accurate for design purposes. The necessary idea for a next approximation was obtained from a realisation of the fact that a wing is always moving into fresh air, whilst an airscrew blade moves into air disturbed by other blades and by the previous passages of the blade itself. The thrust of an airscrew, being produced by dynamic means, involves the throwing back of a mass of air per second the axial momentum of which is equal to the thrust. Owing to the continuity of the airflow, it might therefore be expected that disturbances due to other blade passages would take the form of an "inflow" of air into the airscrew blade. Experiment provides support for, and can be used to give quantitative values to, a theory based on this idea.

In discussions of marine propellers, Froude developed a theory in which half the final momentum of the slip stream was added in front of the propeller disc. Lanchester applied the idea to aerial screws, but, with his sense of the physical incompleteness of the theory, he did not accept "half" as anything more than an approximation. The Fage-Collins theory referred to on p. 19 is merely a theory which supposes that wing elements modified by the assumption of an inflow velocity can be made to agree with an experimental check by the choice of a certain constant closely related to Froude's half.

It is known that a second approximation so made is important, but it is also realised that every unknown quantity, such as the effect of the ends of the blades, their shape, and the changes in type of flow due to centrifugal action, are attributed to inflow. Wood and Glauert devised a scheme for the experimental determination of "inflow" without the above complications, and described their tests in the report referred to by Mr. Fage. It was pointed out that a logical extension of the aerofoil theory would be obtained by placing a succession of aerofoils behind each other in a wind channel so that some of them were working in the disturbed air of blades further into the wind. The relative positions of the blades to correspond with an airscrew were not found to be inconvenient for experiment, and, finally, after tests in a wind channel, a further approximation was made which brought theory nearer to the truth. The differences from the Fage-Collins theory are too great to be dismissed as unimportant, and show that there still remain further factors to be investigated.

This fundamental step in analysis of airscrew performance is the one dismissed by Mr. Fage in less than two pages of his book, and his closing remarks indicate the rather illogical contention that because other points still remain to be explained, the new experiments are of little use. This should surely not be the attitude of research workers at the National Physical Laboratory. It is to be hoped that it does not represent the views of the late Advisory Committee for Aeronautics, to which most of the items of work at the National Physical Laboratory were presented before publication.

This example has been taken at some length as typical of the book, which, on the theoretical side, is sketchy throughout. Perhaps one is tempted to be too critical of a work which largely records war activity. On the other hand, where are we to look for the progressive development of knowledge in aeronautics if such places as the National Physical Laboratory fail us? Is the new Aeronautical Research Committee still accumulating a great mass of undigested material, of which Mr. Fage's contribution is a part, or is it keeping its activities for advice on the general lines of experiment and research? One is not too hopeful that the incubus of the war is being thrown off any more completely by his employers than by the author of the book under notice.

Nomography.

A First Course in Nomography. By Dr. S. Brodetsky. (Bell's Mathematical Series. Advanced Section.) Pp. xii+135. (London: G. Bell and Sons, Ltd., 1920.) Price 10s. net.

THE subject of nomography may be shortly described as dealing with the graphic representation of formulæ. As developed by M. d'Ocagne, there has been an increasing interest taken in recent years in the application of its methods to facilitating calculation in engineering and scientific work generally.

In this "First Course," nomography is arbitrarily restricted to graphic representation in parallel co-ordinates, the resulting diagram being read by the collineation of points. It is true that there is a growing tendency to use the word "nomogram" for such a representation only; but, apart from nomenclature, there are grave disadvantages in this isolated treatment.

For a clear and intelligent appreciation of the subject it is a matter of great importance to keep in the forefront the *principle of duality*, the connection between graphic representation in Cartesian co-ordinates (the intersection diagram) and that in parallel co-ordinates (the alignment diagram), and the transformation of the one into the other.

Throughout the book the explanations are clear and the diagrams excellent, but the former appear occasionally to be unnecessarily diffuse. Nearly fifty pages out of a total of fewer than one hundred and fifty are mainly occupied with a minute description of nomograms for performing simple addition and subtraction, a purpose for which they are seldom practically used. Some introductory reference to them is certainly advisable, but all that is necessary might quite well have been given in a few pages and a couple of illustrations.

Some of the space so saved could with advantage have been devoted to a description of the direct-reading four-variable nomogram, which is a combination of two parallel scales and a network. To this no reference is made, but it is of great importance in practical work.

Diversity of notations is a continual source of irritation in such subjects, but, of course, is at times unavoidable. In the present case it seems a pity that M. d'Ocagne's later notation has not been accepted as standard and used wherever possible. By later notation is meant the one adopted in that writer's "Calcul Graphique et Nomographie" (1908). It is wonderfully concise, without any sacrifice of clarity or completeness, and is quite simple to grasp. M. d'Ocagne evidently considers it an improvement on the more cumbrous notation of his earlier "Traité de Nomographie" (1899), as he has continued to use it in his latest brochure, "Principes usuels de Nomographie avec application à divers problèmes concernant l'Artillerie et l'Aviation" (1920).

Metallurgy for Dental Surgeons.

A Manual on Dental Metallurgy. By Ernest A. Smith. Fourth edition. Pp. xvi + 285. (London: J. and A. Churchill, 1920.) Price 12*s*. 6*d*. net.

SMITH'S "Dental Metallurgy" is read by so many dental students that the goodness or badness of the text has a considerable influence on the stage of knowledge of the embryo surgeon-dentist. Thus for many years it was impossible, even with the help of photomicrographs showing the two metals in patches like the stripes on a zebra, to convince the dental student that a eutectic was a mixure, because the author of this book had declared that such a patchwork might be a chemical compound! This error has, fortunately, been corrected in the new edition, which shows many useful improvements resulting from the incorporation of the rudiments of modern scientific metallurgy.

In spite of these improvements, the general tone of the book is still unsatisfactory, and carries with it the impression that the dental surgeon is content with a much lower standard of knowledge than are his medical colleagues. Thus, in view of the fact that for many years every candidate for the L.D.S. has had to pass an examination in elementary chemistry before taking the test in dental metallurgy, it is almost incredible that a standard text-book should attempt to teach metallurgy without making use of chemical equations. It is, nevertheless, true that the author has described the extraction of the metals from their ores (for which formulæ are usually given) without in any instance providing a chemical equation to express the action which takes place; it must therefore be taken as a singular compliment to the work on dental amalgams, carried out in the Laboratory of Physical Chemistry at Bristol a short time before the war, that it has provided the author with the only example of a chemical equation which the reviewer has been able to discover in the whole of the volume. This treatment of the subject can, however, scarcely be regarded as a compliment to the dental profession; and, even if it represented a reasonable point of view when the first edition appeared in 1898, the time has surely come when dental text-books should be addressed to readers with some knowledge of elementary science, instead of being lowered to the standard of a trade-class of mechanics or plumbers.

T. M. L.

Our Bookshelf.

Peat Industry Reference Book. By F. T. Gissing. Pp. xxiv + 292. (London: Charles Griffin and Co., Ltd., 1920.) Price 7*s*. 6*d*.

THE author, alone or in conjunction with Bjorling, has already published two books on peat. The present volume deals mainly with those developments in the peat industry which have arisen since the publication of the previous books. It is divided into eight sections, dealing with the formation of peat, its winning as cut peat, machine-formed peat and pressed peat, peat gas and its by-products, power gas, peat-moss litter, peat mull and other products, such as alcohol and paper obtainable from peat. The eighth, and last, section contains miscellaneous information, formulæ, and tables, which will be of much use to persons dealing with peat.

The various processes patented, or worked on an experimental scale, have been faithfully described from the point of view of the inventors or exploiters of these processes, and it is this circumstance which constitutes the chief defect of the book. Claims which are experimentally unjustifiable are occasionally admitted into the book without criticism, and for this reason some of the statements made are quite at variance with the actual facts, and are likely to mislead readers unacquainted with the properties of peat. Everyone knows, for instance, that a peat-pulping machine exerts practically no *cutting* action on peat, yet the claim that one peat-pulping machine *cuts the cells* of the peat fibres is passed without comment.

Again, under another process it is stated that wet raw peat contains 20 per cent. of dry peat, and gives 8 per cent. of charcoal. As a matter of fact, wet raw peat from an undrained bog contains only about 8 per cent. of dry peat, and gives only about 2·8 per cent. of charcoal, and even from a well-drained bog the amount of charcoal got from 100 tons of the raw peat rarely exceeds 3·5 tons. It is evident, too, from this book that some "inventors" are still unable to grasp the elementary fact that in order to obtain 100 tons of dry peat from raw peat by the aid of artificial heating somewhat more than 100 tons of dry peat must be burnt to develop the heat required.

Text-book of Pastoral and Agricultural Botany: For the Study of the Injurious and Useful Plants of Country and Farm. By Prof. J. W. Harshberger. Pp. xiii+294. (Philadelphia: P. Blakiston's Son and Co., 1920.) Price 2 dollars.

A KNOWLEDGE of the useful and poisonous plants on a farm is an essential part of the equipment of the agriculturist, but hitherto the requisite information has been to a large extent scattered and difficult of access. In the present volume the account of the stock-killing and poisonous American plants is thorough and comprehensive, a specially useful feature being the inclusion of methods of treatment where they are known. It is a pity that the photographs of affected animals are not reproduced more clearly, as several of them fail to illustrate their point.

The crop plants are dealt with sufficiently, though briefly, and the bibliography at the end of each chapter assists the student to follow up any requisite line of inquiry. It may be suggested that in future editions an "author index" would greatly enhance the value of the book, as at present it is not always easy to determine if a reference is included. The laboratory exercises which follow each chapter are very practical and well thought out, and render the book serviceable to the private worker, as well as to the class student. The same object is attained by the inclusion of a glossary with the detailed index. Prof. Harshberger is to be congratulated on the production of a much-needed working manual, the value of which lies not only in the well-arranged and clearly written information it contains, but also in the suggestiveness which renders it adaptable for use in countries other than America. W. E. BRENCHLEY.

This Wonderful Universe: A Little Book about Suns and Worlds, Moons and Meteors, Comets and Nebulae. By Agnes Giberne. New illustrated edition, completely re-written. Pp. x+182. (London: S.P.C.K.; New York: The Macmillan Co., 1920.) Price 6*s.* 6*d.* net.

MISS AGNES GIBERNE is well known for her charmingly written books on elementary astronomy. This is a new edition of an earlier work, carefully brought up to date, some excellent photographs of the moon, Mars, eclipses, and nebulæ being reproduced. The celestial phenomena are described in clear and vivid language, the difficulties likely to occur to a beginner being answered in anticipation. The book is made more interesting by the inclusion of a certain amount of legitimate speculation on the development of worlds and systems, and the probable condition of the different planets. The concluding section, "Immensity—and Man," deserves thoughtful study.

A few slips should be corrected. P. 69: One of our athletes would only jump 2·6 times as high on Mars as on Earth. "Over a good-sized house" is misleading. P. 84: The paragraph about TG misses the chief interest of the Trojan group of planets—the equilateral configuration with Sun and Jupiter. P. 108: Neptune's orbital speed should be 200 times that of an express train—not three times. P. 124: Two upright sticks a yard apart are not strictly parallel, since both point towards the earth's centre. P. 134: Sun's density is wrongly stated to be less than Saturn's. P. 138 (plate): Date of Mina Bronces eclipse was 1893—not 1889. A. C. D. CROMMELIN.

Practical Physiological Chemistry. By S. W. Cole. With an introduction by Prof. F. G. Hopkins. Sixth edition. Pp. xvi+405. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin, Marshall, Hamilton, Kent, and Co., Ltd., 1920.) Price 16*s.*

IN spite of the fact that a fifth edition of this valuable book was reviewed in NATURE of August 28, 1919, another edition has rapidly become necessary. The volume has been revised and enlarged, and several new methods have been introduced, of which the most important is a modification of McLean's method for the determination of blood sugar. Other additions include Van Slyke's method for the estimation of blood chlorides, and the soya bean method for the estimation of the urea in blood. Six editions of the book have now appeared in sixteen years; this should be a sufficient guarantee of the worth of the contents.

Coal. By J. H. Ronaldson. (Imperial Institute: Monographs on Mineral Resources, with Special Reference to the British Empire.) Pp. ix+166. (London: John Murray, 1920.) Price 6*s.* net.

MUCH information relating to the coal deposits of the British Empire is recorded in this book. The geology of the deposits is described, and the statistics of production and reserves in various countries of the world are given. Apparently the most important coal resources of the world are in the northern hemisphere, particularly in countries near the Atlantic Ocean. Roughly three-quarters of the world's coal supplies are located in North America, principally in the United States, while the British Empire contains less than one-fifth of the known coal deposits of the world. The monograph concludes with a list of references to publications dealing with the coal resources of the Empire.

Science German Course. By G. W. Paget Moffatt. With a glossary by J. Bithell. Third edition (sixth impression). (Science Text-books.) Pp. xii+270. (London: W. B. Clive: University Tutorial Press, Ltd., 1920.) Price 5*s.*

THE third edition of this book is not very different from the first, which was noticed in NATURE of November 21, 1907. All the extracts in Gothic type have been removed to the end of the book, and in place of the separate vocabularies a complete vocabulary of all the words occurring in the extracts for reading has been inserted.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Heredity and Acquired Characters.

(1) MOST biologists believe that the heritage travels down the germ-tract. (2) All biologists believe that in the germ-cell are none of the characters which the individual afterwards develops, but only potentialities for producing them in response to fitting nurture. (3) It follows necessarily that only potentialities are transmitted. (4) All that is transmitted is not produced (as characters of the individual), for fitting nurture may be lacking. (5) Therefore, inheritance and reproduction are not synonymous terms. (6) The individual can produce nothing but what was potential in the germ-cell, and nothing except in response to fitting nurture. (7) Necessarily, therefore, all characters are innate, acquired, germinal, somatic, and inheritable in exactly the same sense and degree. Given these facts and inferences, I asked biologists why they described some characters as "innate," "germinal," and "inheritable," and others as "acquired," "somatic," and "non-inheritable." I gave the example of the head and the scar, both ancient products of evolution. Why, when the child is like his parent both by nature and by nurture, is he said to inherit the head but not the scar? Why is the word "inherit" used as synonymous with "vary," its direct opposite, in the case of the scar? Really, I was asking for such definitions of biological terms as would accord with the current usage of them. As yet I have got none. I think I shall get none.

I may be wrong in thinking that biological terminology is vague, and sometimes even unmeaning, or I may be right. If I am wrong, surely some biologist can give the definitions I ask for. If I am right, the matter is of importance even as a mere question of words. A science cannot progress unless its workers have means of expressing themselves precisely and clearly. Other interpretative sciences—*e.g.* mathematics, physics, astronomy, and chemistry—have such means. It is noteworthy that they all possess in addition a body of established truth—truth which no one who knows the facts disputes. But biology can boast of scarcely an important interpretation (not even the theory of natural selection) which is accepted by everyone. As in religion and politics, its workers are divided into more or less hostile sects and sub-sects—Lamarckians, Darwinians, Neo-Darwinians, Mendelians, mutationists, Mendelo-mutationists, biometricians, and the like. I submit that much of this extreme, and apparently irreconcilable, divergency of opinion is due to confusion of thought consequent on confusion of language.

But beyond words, the matter is important. Biologists classify characters as "innate" and "acquired." Physiologists ignore this classification, and, assuming that all characters develop in response to nurture, endeavour to ascertain what forms of nurture evoke them. In other words, they classify characters according to the nurtures which cause them to develop—use, injury, this or that hormone, and the like. This classification is not merely different from the biological one; it is actually antagonistic; for, of course, if all characters equally arise in response to nurture, they must all equally take origin in germinal potentiality—must be equally innate and acquired. If biologists cannot justify their use of terms (supply valid definitions), it appears to me that they have no alternative but to accept the physiological classification. If that be done, I conceive that some such simple formula as "The sole antecedent of non-inheritance is variation. Apart from variations, like exactly begets like when parent and child develop under like conditions," will almost cover the field of discussion.

In reply to Dr. Ruggles Gates's letter in NATURE of December 2, p. 440, if we believe with Darwin in his theory of pangenesis that the parts of the child are derived from the similar parts of the parent (the child's head from the parent's head, etc.), the distinction between variations and modifications vanishes. Every modification is then a variation. We can distinguish only between germinal and somatic variations. If we believe that modifications in the germ's environment (the soma) may so impress the germ as to cause variations, then I think we are accepting what nobody questions, though I believe the importance of variations so caused has been greatly exaggerated. If we believe that changes in the soma tend to impress the germ-plasm in such a remarkable and unlikely way that the child reproduces in response to a different stimulus the character which the parent produced in response to the stimulus that Nature had fitted his race to respond to, then undoubtedly that child has varied from the parent. He is of a different nature; he has not inherited. I confess I do not see how Mendelians and mutationists *as such* are concerned in this discussion. They think that fluctuations are modifications, and that only mutations are true variations, and, therefore, that only the latter are inheritable—all of which is at least intelligible.

Prof. MacBride and Sir Ray Lankester (NATURE, December 16, pp. 500–1) may conveniently be answered together. But if, after reading what follows, Prof. MacBride will precisely indicate the "quibble" he writes of, I shall be much obliged. In reference to his last paragraph, if the child of a parent with an extra digit lacks that extra digit, or if he is relatively fair, then he has varied from the parent, has he not? Yet he has not departed from what is normal in the species. Prof. MacBride tortures a word which has now an established and perfectly clear meaning.

In 1911–12 I instanced a scar as a so-called "acquired character." Then, as now, Sir Ray Lankester quoted Lamarck in the original French. Lamarck wrote about the effects of use and disuse (not about the effects of injury). Therefore, *pace* Sir Ray Lankester, a scar is not an acquired character. Therefore, "if you, without any warrant, alter the established signification given by the Neo-Darwinian to the chief term in his statement, you can, of course, convert it into nonsense, and your proceeding is merely farcical." It is as if I had asked why kippers were called whales and Sir Ray Lankester had insisted that the term was restricted to red herrings. Fortunately, I am in good company. Did not Weismann himself cut off the tails of rats by way of demonstrating that acquired characters were not transmissible? If in my letter Sir Ray Lankester substitutes any use-acquirements he likes for "scar," his requirements will be met. In 1911–12 Sir Ray Lankester declared I was "doing harm." Influenced, doubtless, by the opinion of so great an authority, the Editor closed the correspondence. Thus was I crushed. The odd thing is that at the time I believed—as I do now—that I was fighting my critic's—or shall I say my contemner's—battles. We had travelled by different roads, but had reached, as far as I could judge, the same goal, and I was seeking to clear the ground. But more of this anon.

If the writings of Lamarck (notably the laws quoted by Sir Ray Lankester) and of those of his successors (*e.g.* Spencer, Romanes, Wallace, Weismann, and even Darwin) be examined, two assumptions will be found—never formally expressed, perhaps, but always apparent. On one hand, it is assumed that all characters develop in response to use. On the other, it is assumed that this development is never considerable. Both assumptions are monstrously wrong. Even in human beings many characters (*e.g.* hair, teeth, external ears, and external organs of generation) do not develop in the least in response to functional activity; on the other hand, in the higher animals, and especially in man, most characters develop from the infantile standard wholly, or almost wholly, in response to that stimulus. Physically and mentally man is the educable animal. He is immensely responsive to both use and disuse.

Low in the animal scale we find little or no evidence of development in response to functional activity. Apparently, even in an animal so high in the scale as a butterfly, use does not cause development nor disuse atrophy. In the egg use plays no part. We have no grounds for supposing that any structures grow during the caterpillar stage *because* they are used. In lack of functional activity the butterfly's structures develop vastly in the chrysalis. Afterwards functional activity does not cause them to grow. The evidence as regards mind is even clearer. In all its conscious phases this animal seems purely instinctive. It does not profit from experience, it does not learn, it is not educable. At any rate, if it develops at all in response to mental functional activity, it does so to a very small extent. Higher in the scale animals are born more and more helpless, but more and more capable of developing in response to use. Nature substitutes "acquired" for "innate" characters. That substitution marks the higher animal. Presently we find animals so capable of learning that mates are able to recognise one another, and also to recognise offspring. Thus family life arises, whereby offspring are afforded opportunity to develop in response to use. At last we reach man, who is born particularly helpless and immature, but enormously capable of growing through use, both in mind and in body. To this potentiality he owes all his adaptability, all his morality, religions, intelligence, knowledge, his whole intellectuality.

Now consider whether the problem of the "transmission of acquired characters" furnishes materials "for a legitimate inquiry." (1) The evolution of the power of developing in response to use is *the* feature of the rise of the higher animals. Steadily this potentiality increases at the expense of other potentialities. It may be argued, therefore, with some appearance of plausibility, that "innate characters" tend to be "transmitted" as "acquirements"; but the supposition that "acquirements" tend to become "innate" is, in the face of enormously massive evidence, ridiculous. (2) For thousands of generations the muscles of the boy have developed into those of the ordinary man in response to use, but no one has suggested that these "acquirements" tend to be "inherited"—to develop in the lack of use. But let one man (*e.g.* a blacksmith) display his human adaptability by developing his muscles by a little more use, and the Lamarckian immediately begins to wonder whether this last scrap of development is "transmissible." (3) Acquirements consequent on use and injury (made as Nature designed them to be made) are all useful. Transmitted, they would be less useful, or useless, or, more often, burdensome. For example, of what utility would scars be to an unwounded man, or the muscles of a blacksmith to his descendant the clerk? Lamarckians gravely argue, in effect, that after Nature has expended millions of generations in evolving a useful trait, this trait, directly it appears, tends to be converted into a useless trait. Here we have the oddest view of evolution conceivable.

To us as rational beings the evolution of the power of developing in response to use is immensely the most important phase of evolution. Of course, everyone is more or less aware of it. Thus parents know that it is necessary to train children, and even schoolboys know that men are more educable than dogs, dogs than cats, and so on. But it is remarkable how this tremendous truth has been ignored in scientific literature. If Lamarck and his supporters had realised it, would they have argued for the transmission of acquired characters? If Weismann and his followers had realised it, would they have condescended to argue against such transmission? Would any men have asked whether nature or nurture is the stronger? Would they have concluded that "nature is certainly five, and perhaps ten, times stronger than nurture"? What caused all this blindness to exceedingly obvious truth? Plainly, it was caused by the classification of characters as "innate" and "acquired." This led to the assumption that use-acquirements are of trivial magnitude, and so threw a veil over reality.

Men of science who study organic Nature—zoologists, botanists, palæontologists, anatomists, physiologists, bacteriologists, psychologists, and the like—are necessarily specialists and, unless they pass the boundaries of their particular studies, very narrow specialists. Biology supplies the connecting links. Every science is at first purely descriptive. Later, as the woof to the warp, interpretation is added. As Newton interpreted facts of astronomy, so Darwin accounted for the structures which zoologists, botanists, and palæontologists describe. Physiology is accounting for the facts of anatomy. It tells, among other things, of the influences in response to which structures develop. Pathology and bacteriology are accounting for the facts, that medical men have described, in terms of causation (nurture). But psychology is as yet, in very great measure, purely descriptive, and, even so, in a very limited field. Perception, conception, association, and the like have been described, but there are other and, for people who seek practical results, even more important characters—*e.g.* courage, cowardice, chivalry, meanness, energy, prejudice, and, above all, intelligence and stupidity. How do these traits, which in their sum constitute individual and national "character," develop? Do they arise in response to training (functional activity), or in response to influences (hormones and the like) largely beyond our present control?

Only biologists are able to settle these problems, for they alone are in a position to combine knowledge sufficiently deep and wide with relative freedom from blinding prejudice, religious and other. Presently, when, drawing on the vast stores of verifiable evidence which are available, they account indisputably for the various items of human character, science will come into its own. It will then have an indisputable title to control education and make it scientific in the sense that right means are adapted to achieve desired ends. It will raise issues far more burning and vital than even Darwin and Huxley raised. It will give a new reading to history. This is what I meant when I said I believed I was fighting Sir Ray Lankester's battle. But, obviously, the first step must be to achieve a right terminology, and so a valid classification of fundamental data. How, then, shall we classify characters—as "innate" and "acquired," or as responses to this or that form of nurture? This is what I meant by "clearing the field."

Of one thing I am very sure: that so long as the present classification is maintained biology will never be other than a tumbling-ground for whimsies—Lamarckian suppositions, questions as to whether nature or nurture is the stronger, and the like. When Darwin, the greatest figure that biology has produced, worked on lines of Lamarck's classification he went hopelessly wrong—as in his theory of pangenesis. His whole success was achieved when he studied, not differences between characters, but differences between individuals.

Prof. Poulton's letter in NATURE of December 23, p. 532, which I have seen since writing the above, is valuable for its line of thought and for its definitions. He begins by comparing *individuals*, and finds that their likenesses and differences are separable into those which are inherent (blastogenic) and those which are acquired (somatogenic). This is the firm ground which Darwin occupied in all his valid thinking. No one doubts the existence of these likenesses and differences, and most biologists believe that only those which are blastogenic tend to be inherited (perpetuated) by offspring. Thus chicks resemble each other innately in that they have heads and differ by acquirement as regards scars. Next, Prof. Poulton transfers the terms "inherent" and "acquired" from the likenesses and differences between individuals to the *characters* wherein they are alike or different. The head is called "inherent" and the scar "acquired." He is now comparing the characters of the same individual. This change, subtle yet vital, is precisely the cause of the chaos which prevails in biology. We are now in the morass in which Lamarck and Weismann floundered. We have departed altogether from Darwin's point of view. We have transferred the argument from the chestnut horse to the horse-chestnut. In what particular is the head more inherent and less acquired than the scar? Prof. Poulton writes: "Whenever change in the environment regularly produces appreciable change in an organism, such difference may be called an acquired character." Suppose I decide to work harder and so develop my muscles beyond the ordinary standard which they have already attained through use. In what respect is the addition more "acquired" than the ordinary development (which is usually termed "innate")? What would be the change in the environment?

I think I can give Prof. Poulton better definitions. Whenever the influence in response to which a character (*e.g.* a blacksmith's muscles, scars) develops is *glaringly* obvious, biologists call that character "acquired" and "somatogenic"; but whenever the influence is *not glaringly* obvious (*e.g.* ordinary muscles, head) that character is called "inherent" and "blastogenic." Whenever a biologist considers a character innate he reasons as if the soma and nurture had nothing to do with it. Whenever he considers it "acquired" he reasons as if the germ-plasm and nature had nothing to do with it. In all this he adheres strictly to ancient popular usage, and is not troubled by such recently discovered, recondite things as germ-plasms and germ-cells. He may talk about the latter unendingly, but they do not influence his thinking. Situated at the hub, whence radiate all sciences connected with life, biology, because of its unique classification of characters, has rendered not only itself, but also all these other studies relatively impotent—intellectually, socially, politically. It can use their data only to a minimal degree; and is not used by them at all.

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The British Committee for Aiding Men of Letters and Science in Russia.

WE have recently been able to get some direct communication from men of science and men of letters in North Russia. Their condition is one of great privation and limitation. They share in the consequences of the almost complete economic exhaustion of Russia; like most people in that country, they are ill-clad, underfed, and short of such physical essentials as make life tolerable.

Nevertheless, a certain amount of scientific research and some literary work still go on. The Bolsheviks were at first regardless, and even in some cases hostile, to these intellectual workers, but the Bolshevik Government has apparently come to realise something of the importance of scientific and literary work to the community, and the remnant—for deaths among them have been very numerous—of these people, the flower of the mental life of Russia, has now been gathered together into special rationing organisations which ensure at least the bare necessaries of life for them.

These organisations have their headquarters in two buildings known as the House of Science and the House of Literature and Art. Under the former we note such great names as those of Pavlov the physiologist and Nobel prizeman, Karpinsky the geologist, Borodin the botanist, Belopolsky the astronomer, Tagantzev the criminologist, Oldenburg the Orientalist and permanent secretary of the Petersburg Academy of Science, Koni, Bechterev, Latishev, Morozov, and many others familiar to the scientific world.

Several of these scientific men have been interviewed and affairs discussed with them, particularly as to whether anything could be done to help them. There were many matters in which it would be possible to assist them, but upon one in particular they laid stress. Their thought and work are greatly impeded by the fact that they have seen practically no European books or publications since the Revolution. This is an inconvenience amounting to real intellectual distress. In the hope that this condition may be relieved by an appeal to British scientific workers, Prof. Oldenburg formed a small committee and made a comprehensive list of books and publications needed by the intellectual community in Russia if it is to keep alive and abreast of the rest of the world.

It is, of course, necessary to be assured that any aid of this kind provided for literary and scientific men in Russia would reach its destination. The Bolshevik Government in Moscow, the Russian trade delegations in Reval and London, and our own authorities have therefore been consulted, and it would appear that there will be no obstacles to the transmission of this needed material to the House of Science and the House of Literature and Art. It can be got through by special facilities even under present conditions. Many of the publications named in Prof. Oldenburg's list will have to be bought, the costs of transmission will be considerable, and accordingly the undersigned have formed themselves into a small committee for the collection and administration of a fund for the supply of scientific and literary publications, and possibly, if the amount subscribed permits of it, of other necessities, to these Russian *savants* and men of letters.

We hope to work in close association with the Royal

Society and other leading learned societies in this matter. The British Science Guild has kindly granted the committee permission to use its address.

We appeal for subscriptions, and ask that cheques should be made out to the Treasurer, C. Hagberg Wright, LL.D., and sent to the British Committee for Aiding Men of Letters and Science in Russia, British Science Guild Offices, 6 John Street, Adelphi, London, W.C.2.

MONTAGU OF BEAULIEU, BERNARD PARES,
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The Pea-Crab (*Pinnotheres pisum*).

THERE is an apparent discrepancy between Dr. J. H. Orton's interesting description of the pea-crab in NATURE of December 23, p. 533, and that given by Dr. W. T. Calman, whom he quotes. Dr. Orton attributes the impunity with which the male crab and the male-like female sustain the nip of a bivalve to their "extraordinarily strong carapace" (p. 534). On the other hand, Dr. Calman, discussing whether the Pinnotherid crabs should be reckoned commensals or parasites, observes that they "show one of the characteristics of parasites in being to some extent degenerate in their structure. The carapace and the rest of the exo-skeleton, no longer needed for protection, have become soft and membranous" ("Life of the Crustacea," p. 217).

Does not Dr. Calman's suggestion tend to confound racial degeneracy (such as environment has imposed upon Crustacea and fishes inhabiting subterranean waters, or such as has been induced by habit of life on certain parasitic species of Hemiptera) with modification of growth and adaptation of functional activity in individuals approaching parturition? If the female crab does not, after moulting within the bivalve, renew the hard carapace which protected her in obtaining entrance, the diversion of nutriment to her swelling spermothecæ can scarcely be accounted degeneracy. Rather it suggests analogy to the extreme case of *Termes bellicosus*, the so-called white ant, which is neither parasitic nor, presumably, racially degenerate, but the queen-mother of which is perennially and unintermittently parturient, with the result that, according to Smeatham, her abdomen "grows to such an enormous size that an old queen will have it increased so as to be fifteen hundred or two thousand times the bulk of the rest of her body," and twenty or thirty times the bulk of one of her worker offspring.

Dr. Orton having carried research into the pea-crab's life-history a stage further than Dr. Calman, it is to be hoped that he will soon be able to announce a complete solution. HERBERT MAXWELL.

Monreith.

The Mechanics of Solidity.

IN connection with the correspondence on this subject in NATURE, attention may be directed to the attempts made by C. Benedicks (*Zeit. f. anorg. Chem.*, vol. xlvii., p. 455, 1905; *Ann. d. Physik*, vol. xlii., p. 153, 1913) to relate the hardness (H) to the other physical properties of the substance. He suggested that H is inversely proportional to the atomic volume (V) and to the coefficient of expansion (α), and therefore $HV\alpha$ is constant for different elements. This result includes the relation given by Mr. J. Innes (NATURE, November 18). Benedicks also proposed a new formula for the characteristic frequency (ν) of an element of atomic weight A in the solid state. He assumed that the frequency is proportional to $\sqrt{(H/A)}$, and hence to $\sqrt{(1/V\alpha A)}$. If the further assumption be made that the frequency so determined is identical with the frequency given by one or other of the formulæ summarised by Mr. N. T. Saunders (NATURE, December 23), other relations between the physical constants may be obtained. For example, according to the Sutherland-Lindemann formula ν is proportional to $\sqrt{(T_s/AVl)}$, where T_s is the melting point on the Absolute scale. Combining this with the previous result, we find αVlT_s=a constant, a relation given by Pictet in 1879.

I cannot altogether agree with Mr. Saunders (NATURE, December 23, p. 534) in his omission to consider the hardness in relation to other physical constants mentioned on the ground that it is a surface effect and not a bulk effect. Although the conditions at the surface differ from those in the interior of the solid, those conditions are determined by forces of the same general character in each case. In the case of a liquid a large number of relations between surface tension or intrinsic pressure and other physical and chemical constants have been given, and Laplace's theory points the way towards the co-ordination of these results. Reference may be made to the book by Willows and Hatschek on "Surface Tension and Surface Energy" (Churchill), in which this matter is discussed, and the conclusion that *solids* ought to possess surface tension and intrinsic pressure is emphasised. Mr. Saunders, if he is to be consistent, should omit reference to the melting point as well as to the hardness value, since a pure crystalline solid melts on the surface only, and the melting point is the temperature at which the solid can exist in equilibrium in contact with its own liquid under a specified pressure.

Mr. Saunders is no doubt correct in maintaining that further attempts to relate mechanical and other physical constants of solids must be based on modern theories of the structure of the atom.

H. S. ALLEN.

The University, Edinburgh.

The Meteorology of the Antarctic.

IN the preface to my book on Antarctic meteorology I wrote, "I was recalled to my work in India when the *Terra Nova* returned to the Antarctic in January, 1912," and the reviewer in NATURE of December 23 (p. 528) has very naturally concluded that this meant that I was recalled officially by the Government of India. It is, therefore, only fair that I should state the facts. I was granted three years' leave by the Government of India, which would have been sufficient if Capt. Scott's original plan of staying only one year in the Antarctic had been carried out. When, however, it was clear that the expedition would remain two years, I told Capt. Scott that I would stay the second year and write to India asking for my leave to be prolonged. When the *Terra Nova* arrived in January, 1912, she brought me a letter from Mr. Field telling me that Dr. Walker had gone to England seriously ill, and that he himself was so unwell that he did not see how he could carry on. In these circumstances I felt it was my duty to my colleagues in India to return at once.

I think most people will understand how in such circumstances I came to write that I was "recalled" to India, but it was an unfortunate expression, and would not have been used if I had realised the inference which would be drawn from it.

G. C. SIMPSON.

Meteorological Office, London, December 27.

The Mammals of South Africa.[1]

THE first two volumes of the work before us were noticed in NATURE of January 8, 1920, p. 469. We recommended them as containing a store of valuable information on the habits of the wild beasts. A vivid and often fascinating description of the species, with many excellent illustrations, made the perusal of these volumes a particular pleasure.

A study of the two volumes now before us justifies our recommendation. The illustrations are mostly good, while the text is clear and attractive. Technical terms have been avoided as much as possible, and in many cases the author gives us the origin and description of the Dutch terms by which the animals are generally known in South Africa.

No wonder South African farmers often lack that sympathy for the preservation of wild animals, and sometimes ruthlessly destroy everything that they fancy is harmful to agriculture. A number of species have already been exterminated, and are known only from old records and from a few specimens still scattered about in various museums. Of the interesting bluebuck, all that is left are five mounted examples, and, sadly enough, these are in foreign museums. Of the quagga there are, fortunately, a few representatives in our great collections. Yet an enlightened Government now protects species that seem to need protection. The bontebok, blesbok and springbuck, the noble kudu and eland, the African buffalo, and even the white rhinoceros and elephant, are carefully preserved in specially reserved areas.

FIG. 1.—Blesbok. From "The Natural History of South Africa."

The prospective emigrant to that part of the world who may seek some enlightenment from these volumes will be struck by the extraordinary wealth and profusion of the fauna. What a paradise for the sportsman! From the farmer's point of view, however, the truly distressing prospect has to be faced of dealing not only with almost innumerable kinds of antelopes and other large game, but also with twenty-four different kinds of rats, including a giant rat attaining a length of 2 ft. without the tail; with wild pigs and hares; with many species of moles and other underground creatures; and with a voracious porcupine, all eager to obtain their share of the fruits of agriculture.

Reckless and indiscriminate slaughter in the past is no doubt partly responsible for the rarity and extinction of some of the larger game; but at times it became necessary for the farmer to take energetic measures for the protection of his crops. The stories of the vast herds of such antelopes as the springbuck remind us of the description of the American bison in the United States. At certain times the springbuck used to migrate in countless numbers into the fertile districts of South Africa. So prodigious were the numbers that the springbuck even choked the streets of the smaller villages. As late as 1892 a special issue of rifles was made to the Boers by the magistrate of the northern border of Cape Colony for the purpose of turning aside a threat-

[1] "The Natural History of South Africa." By F. W. Fitzsimons. "Mammals." In 4 vols. Vol. iii., pp. xiii+278; Vol. iv., pp. xix+271. London: Longmans, Green, and Co., 1920.) Price 12s. 6d. each vol.

ened invasion of migrating springbuck which would otherwise have utterly ruined the crops in the district (vol. iii., p. 92).

Man, however, is not altogether to blame for the scarcity of some of the larger animals of South Africa. Rinderpest undoubtedly played havoc among them, and large numbers of kudu, African buffalo, and others are known to have been decimated by this dread disease.

The smallest of the South African antelopes, about the size and weight of a large hare, is the blue duiker. It is wonderfully alert, and possesses the senses of sight, hearing, and scent in a high degree of perfection; so much so, indeed, that the bushbuck is believed to have made some sort of compact with it for their mutual protection (vol. iii., p. 42).

The fourth volume deals with the insectivores, rodents, whales and their kindred, and the edentates. One of the most interesting features of the South African fauna is the presence of the golden moles. Though very similar in habit to their European relations, the golden moles differ from them in structure and colour, and have been placed in a distinct family. It is worthy of note that an extinct relation of this isolated group (Necrolestes) has been discovered in the Santa Cruz deposits of Patagonia. The several curious burrowing rodents—viz. the blesmol, mole rat, and sand mole—are sometimes mistaken for true moles. They belong to quite a different order, and feed on roots, whereas the golden moles are insectivorous. The author's statement (vol. iv., p. 170) that two species of the octodont tribe of rodents inhabit South Africa requires some modification, for probably neither of these should be included in the family Octodontidæ. Right at the end of the fourth volume, instead of at the beginning of the work, the author explains what is meant by the term "mammals."

We have already commented on the author's charm of style, and throughout his work he makes one feel that he has acquired his extensive knowledge in the open field and has a personal and intimate acquaintance with most of the species he describes.

FIG. 2.—Aardvark. From "The Natural History of South Africa."

Science of Ventilation and Open-air Treatment.

DURING the war it was found that the physical condition of many of our young men was far from satisfactory, and there can be but little doubt that one of the contributory causes to this state of affairs was the ill-ventilated dwellings and factories in which such men frequently had to live and work, combined with a lack of opportunity or disinclination to take exercise. For example, in one region of England, of 200 youths of eighteen to twenty years of age examined and rejected, no fewer than eighty-five failed to pass on account of poor physique and other physical defects.

One important cause of defects of physique and of degeneration is the effect of occupation on workers. "One of the most striking features of the report of grading in the industrial districts is the rapid fall of the numbers of the young men who could be placed in Grade I. at the age of eighteen years compared to the numbers who could be placed in the same grade on being examined four or five years later" (Sir J. Galloway, *British Medical Journal,* September 11, 1920).

A second great cause of rejection was tuberculosis, much of which was unsuspected. Careful statistics from one city revealed the striking fact that of 277 cases proved to be tuberculous, 218, or 78 per cent., were previously unknown to the health authorities.

Such being the state of affairs, the publication of the second part of Dr. Leonard Hill's monograph[1] on the science of ventilation and open-air treatment is particularly to be welcomed. Containing much new work, the volume really comprises a series of essays reviewing the subject from various points of view, both theoretical and practical. The opening essay, in which Miss D. Hargood-Ash collaborated, is devoted to the physics of radiation, and presents the recent knowledge in regard to radio-active elements and the electrotonic theory. The final chapter deals with modern methods of ventilation and heating.

For several years past Dr. Hill, in conjunction with various colleagues, has been devoting his attention to this question. According to the popular notion, "stuffiness" and "closeness" of the air are due to an excess of carbon dioxide in the air, or to organic poisons from the breath. All recent work goes to prove the falsity of these old views. In regard to the latter hypothesis, all the positive results so far recorded as to the poisonous effects of the condensed moisture of the breath can be explained on the assumption that either the amount of condensed fluid injected into an animal was in itself sufficient to kill the animal by virtue of its comparatively great volume, or that the impurity arose from the protein of condensed saliva.

In regard to the carbon dioxide content of the air, much money has been spent in keeping the percentage of this gas down to the requirements of the authorities, yet up to 3 per cent. of carbon dioxide in the air breathed produces no unpleasant effects; with each breath it is a natural act to inspire the dead space air into the lungs, air which in itself contains about 3 to 4 per cent. of carbon dioxide. Indeed, the partial pressure of carbon dioxide in the alveolar air is the normal regulator of the respiratory act. Again, the ill-effects of "stuffiness" have nothing to do with smell; frequently those enduring the smell have no idea of its presence or potency.

It is now abundantly proved that the enervating effects of close and confined atmospheres are due to "heat stagnation" within the body. This is particularly liable to occur when the wet-bulb temperature is high, and efficient evaporation from the skin through sweating prevented. The discomfort under such conditions is alleviated by the use of fans which stir up the air. One of the most illustrative experiments in this direction is that in which a number of persons were confined in a hermetically sealed chamber in which a high wet-bulb temperature was induced by means of trays of water placed above electric heaters. At the height of discomfort to those inside, people outside the chamber could breathe the air without ill-effects. Circulation of the air by fans in the roof brought great relief to the occupants of the chamber.

The chemical purity of the air is important in so far as it may give an indication of infective bacterial content, and in certain trades in which the atmosphere becomes laden with dust particles, particularly silica dust. It is also important from the public point of view as regards the pollution of the air by excessive coal consumption. Coal consumption fouls the air with soot and smoke, producing fogs which diminish sunlight, thereby making cities dismal, and bringing loss of health and happiness to the town dweller. Herein the dweller in the country is at an advantage. Vital statistics show that, despite all the sanitary advances of recent years, the town dweller is still at a disadvantage as compared with the countryman, who frequently lives in any but hygienic surroundings. The country dweller owes his relatively robust health to many of the factors which make for success in open-air treatment.

The success of this treatment in tuberculosis depends upon its judicious application. Exposure to moving air induces efficient respiration, exalts the metabolism, and lowers the fever. It must be so employed that the bodily functions are not depressed and the heat-regulating capacity of the individual exceeded. The patient must always be happy and comfortable. As Dr. Hill puts it: "The ideal conditions out of doors are seen to promote the feeling of comfort and happiness, a gentle cooling breeze to promote adequate cooling of the skin and stimulate the metabolism of the body, coolness and low-vapour tension of the air to promote the evaporation of water from, and blood-flow through, the respiratory membrane."

The clothing of the body, in both health and disease, should always be directed to the prevention of heat stagnation. Many people greatly overclothe. Clothes should be as light as possible, permeable to air, allow free evaporation, and not become wet with water vapour in such a way that they cling to the skin and cause undue heat loss and a feeling of "chilliness." Permeability is essentially a matter of the method of weaving. The cellular type of weaving is to be recommended on this account for underclothing; for outer clothing close-meshed fabric is also to be avoided. Wool owes its advantage in underclothing to the fact that the elasticity of the hair keeps the garment off the skin, thereby securing an air layer beneath which facilitates evaporation and prevents clinging wetness. The less the adherence, the greater the volume of entangled air, and the greater the heat-

[1] Privy Council. Medical Research Council. "The Science of Ventilation and Open-air Treatment." Part ii. Special Report Series, No. 52. Pp. 295. (London: H.M. Stationery Office, 1920). Price 6s. net.

retaining power, even of the wet material. In tropical climates there is particularly a great disadvantage in clothes which lessen evaporation. Heat-stroke is due to excessive heat stagnation.

In regard to indoor conditions, these should approximate as near as possible to the outdoor conditions of an ideal day.

Successful ventilation not only prevents heat stagnation of the body, but also keeps the temperature such that it stimulates the worker without producing uncomfortable cooling of the body.

In the British climate, of mist and cloud, radiant heat is always preferable to convected heat, hence the superiority of the open fire and the modern gas-stove. Radiant heat makes up for the absence of sunlight. Buildings should always, so far as possible, be warmed in such a manner as to keep the feet warm and the head cool. The judicious employment of fans to impart air movement will frequently make all the difference between good and bad ventilation. Dr. Hill's kata-thermometers prove of the greatest service in investigating the ventilation conditions of any building, and it is certain that they must be extensively employed in future to ensure satisfactory conditions, particularly in large buildings.

The question of the bodily heat regulation in the tropics is one of vital importance to the colonising white man. For years past there has been discussion as to whether it is possible for the white man to adapt himself efficiently to tropical climates, or whether this can be done only by pigmented races. Many authorities have inclined to the latter view.

The effect of the tropics is largely due to the action of the sun's visual rays, particularly those of the blue end, which, if sufficiently powerful and prolonged in action, have a lethal effect upon protoplasm. The ultra-violet rays are filtered out by the horny layer of the epidermis. The scales of the skin reflect diffusively many of the visual rays, particularly when the skin is wet with sweat. The function of pigment is to absorb the visual rays, thereby protecting the blood and living tissues from dangerous effects. The pigmented man can, therefore, have a thinner horny layer to his skin, and lose heat well through flushed blood-vessels, without risks of injurious effects from ground glare and sky shine. The view which attributes a higher heat-emissive power to the skin of the negro is erroneous. Despite the above advantages, however, pigment puts an extra tax on the heat-regulating mechanism of the body, since it has to get rid of the heat into which light rays are converted.

The great value of pigment is that it protects man from sunburn, and enables him to go naked and secure the full cooling power of the environment by losing heat by radiation, convection, and evaporation. The white man wears clothes to protect himself from sunburn, and the ill-effects of tropical climates are largely due to the wearing of unsuitable clothing, frequently from custom or from an idea of caste distinction. The white man also usually indulges in an unsuitable diet, which sets his heat production at too high a level. For this reason it is imperative that the white man in the tropics shall be suitably clothed and adjust his diet to the climate, resting during the hot hours, and taking exercise freely during the cool of the day.

The efficiency of the yellow races in hot climates shows that climatic adaptation to the tropics does not depend solely on pigmentation of the skin. As shown above, such adaptation seems to depend upon the correct correlation between the metabolism and the heat-losing mechanism of the body. Given proper sanitary measures against infectious disease, much can be done to promote the efficiency of the white race in hot climates by getting rid of the stagnant moist environment produced by clothes and houses. These in particular tell at present against the health of white women.

M. F.

The Discovery of Fossil Remains of Man in Java, Australia, and South Africa.

By PROF. A. KEITH, F.R.S.

PROF. EUGENE DUBOIS, the discoverer of Pithecanthropus, has recently published[1] an account of fossil remains of man found in a deposit in Java, which he regards as of Pleistocene age. In 1890, the year before he made his first find of the remains of Pithecanthropus at Trinil, Prof. Dubois was led to search for traces of ancient man in the district of Wadjak, which lies some sixty miles to the south-east of the site where his more famous discovery was made. His attention had been directed to the Wadjak district by the discovery there of a fossilised human skull in 1889. Further excavations of the terrace-like deposit in which the first skull had been found placed Prof. Dubois in possession of fragments of the jaws and cranium of a second individual, which were in the same state of mineralisation as the skull which first came to light.

Prof. Dubois has only now published a full account of these discoveries, made thirty years ago. He finds that the remains unearthed at Wadjak indicate that Java was at one time inhabited by a people very like the blacks of Australia, but in some respects even more primitive than they. The publication of an account of a fossil human skull found at Talgai, Queensland, by Dr. Stewart A. Smith[2] in 1918 has apparently induced Prof. Dubois to reinvestigate the fossil remains from Wadjak, and to compare them with the ancient Talgai skull. Thus for the first time it is possible for anthropologists to compare

[1] "De Proto-Australische fossiele Mensch van Wadjak (Java)," *Kon. Akad. van Wetensch. te Amsterdam Afdeeling*, May 29, 1920.

[2] Phil. Trans., 1918, ser. B, vol. ccviii., p. 351

the ancient inhabitants of Java and Queensland. The discovery in 1913 of fossilised human remains at Boskop, in the Potchefstroom district of the Transvaal, throws a welcome light on the ancient inhabitants of South Africa, and gives the means of comparing the early inhabitants of remote continents. An account of the Boskop find was contributed to NATURE for August 5, 1915, vol. xcv., p. 615, by Mr. F. W. FitzSimons, of Port Elizabeth Museum, and a detailed description of the remains has since been published by Mr. S. H. Haughton.[3] In none of these discoveries, in Java, in Queensland, or in South Africa, has it been possible to give a definite geological age to the deposits in which the human remains occurred, yet in each case a Pleistocene date has been assigned to the remains by their describers—an inference which is justified, not only by their condition and surroundings, but also by the primitive structural features which are stamped on them.

The more complete fossil skull described by Prof. Dubois is that of a woman showing features which characterise Australoid races, save that the dimensions of the skull are excessive. The length of this ancient woman's skull is 200 mm. and its width 145 mm., measurements which are rarely met with even in the most robust Australian male aborigines. Prof. Dubois, allowing for the great thickness of the cranial wall—10 mm. on the vault—estimates that its cranial capacity or brain space was 1550 c.c.—more than 200 c.c. above that of the average modern Englishwoman. The jaws of the second individual found are much larger and more robustly framed than those of the woman, and are inferred by Prof. Dubois to represent the opposite sex. The upper jaw and palate of this ancient man of Java are such as have never been seen before in either ancient or modern man. In anthropoid apes the molar teeth are set in two approximately parallel rows on each side of the palate; this arrangement is more exactly preserved in the extinct natives of Tasmania, and to a less degree in the native tribes of Australia, than amongst any other existing race of mankind. But in the Java or Wadjak skulls, although Australoid in all their cranial and facial features, the teeth are set on the palate in a horseshoe form, much as is the case in the Pleistocene European—*Homo neanderthalensis*. The teeth, however, show none of the dental characteristics of that race. The width of the palatal area of the Wadjak fossil man, measured between the outer borders of the second molar teeth, is 81 mm., 7 mm. more than has yet been observed in any human palate. The length of the palate—measured from the crowns of the incisors to a line joining the hinder borders of the last molar teeth—must have been well above 60 mm.—a measurement occasionally exceeded in the palates of modern Australian natives. The palatal area, enclosed within the outer border of the dental arch, is enormous, being, according to Prof. Dubois' estimate, 41·4 sq. cm., to which some 4 sq. cm. must be added on account of the missing incisor crowns. The corresponding area of the average modern Englishman is 26 sq. cm.; the largest measurement in living native races is 36·7 sq. cm. These figures give some indication of the remarkable jaw and face development of the fossil Wadjak race.

The Talgai skull from Queensland, described by Dr. S. A. Smith, of Sydney University, is that of a lad of about fifteen or sixteen years of age. Its cranial walls had been severely crushed by earth-pressure, but fortunately the palate and face are in good condition—a most fortunate circumstance, for it becomes more and more evident that we must trust to facial rather than to cranial features for the recognition and discrimination of human races. So far as the cranial features and dimensions of the Talgai lad are preserved, they show Australoid characteristics—the cranial capacity being certainly above that of Australian aboriginal youths of the present day. Here, again, the outstanding character of the fossil type is to be found in the palate, which has been very fully investigated and described by Dr. S. A. Smith. In the form of its dental arcade the Talgai skull possesses the most anthropoid palate yet discovered. Very probably, were the palate of Piltdown man to be found, it would show these anthropoid features to an even greater degree. The two canine teeth in the Talgai boy are set very widely apart, almost as widely as the molar teeth. The width of the palatal area is 66·5 mm.; allowing for the unerupted wisdom teeth, its length amounts to about 70 mm.; the total area, although less than on the Javanese fossil Australoid skull, is still very large, amounting to about 40 sq. cm.

Thus we have evidence which seems to justify us in supposing that at a certain period of the Pleistocene age men fashioned in a primitive Australoid mould, with large brains and massive palates, lived in Java and Australia; but so far as the palate is concerned the fossil stock of Java had differentiated in one direction, the Australian in another. It is amongst the extinct race, which inhabited Tasmania down to modern times, that we find the nearest approach to the anthropoidal palate and the massive teeth of the Talgai boy. On a consideration of all his features we must place the Talgai boy in the ancestral stock of the Tasmanian type of Australoids. Dr. S. A. Smith cites the discovery of the fossil bones of the dingo in Australian deposits of Pleistocene date as evidence of the early arrival of man in the continent of Australia, for it is difficult to believe that the native dog arrived save in the company of man. The discoveries made at Talgai, in Queensland, and at Wadjak, in Java, lend strong support to this early arrival of man in Australia. Whether the Talgai lad represents the first invaders, and whether these early comers were the primitive ancestors of the aborigines of Tasmania, are doubts which must be settled by future discoveries.

[3] Trans. Roy. Soc. South Africa, 1917, vol. vi., p. 1.

In strange contrast to these ancient inhabitants of Java and Queensland is the ancient type of South Africa represented by the Boskop man. The characters of his skull are so peculiar that we must regard him as a separate and hitherto unknown type. As to his facial characters we know little; his eyebrow ridges and forehead show certain features which give grounds for the belief that the face was flattened—much as in living representatives of the Hottentot and Bushman stocks. From the fragmentary lower jaw one infers that the teeth and palate were of very moderate dimensions—not much larger, if any, than in modern Europeans. The dimensions of the cranial cavity, on the other hand, are enormous: the length of the cranium is 205 mm.; its width 154 mm.; and its capacity or brain space is estimated by Mr. Haughton to be 1832 c.c.—about 350 c.c. above the average for Englishmen. The vault of the skull is thick and flat, two great parietal bosses of bone rising up on each side of its median suture and marking the sites of the parietal eminences. There are also peculiar features in the region of the mastoid process behind the ear and in the zygomatic-temporal region in front of it. The only fossil skull which shows any marked degree of resemblance to the Boskop specimen is the Olmo skull found in a Pleistocene deposit in the north of Italy in 1863. It, too, is a very wide and long skull, with flat roof and projecting upper forehead, but showing none of the peculiar features of the Boskop skull. Mr. Haughton has rightly recognised that certain traits which are found in the Hottentot and Bushman skulls, as well as in the Boskop cranium, can best be explained by supposing the Boskop man to stand in the Pleistocene ancestry of those puzzling Mongolian negroids of South Africa—the Hottentots and Bushmen. Further, on the strength of the evidence referred to in the foregoing, we find, at a remote period in South Africa and in Australia, primitive representatives of the native races now occupying these countries; differentiation from the primitive to the modern type seems to have taken place *in situ* in each case.

Obituary.

THE death occurred on Thursday, December 23, of MR. FRANK PULLINGER, C.B., Chief Inspector of the Technological Branch of the Board of Education. Mr. Pullinger, who was born in 1866, was educated at Manchester Grammar School, Owens College, Manchester, and Corpus Christi College, Oxford. He took a First Class in the Final Honours School of Natural Science in 1887, and in 1889 was elected Burdett Coutts scholar of the University. After spending a year in research work at Oxford and another year as a University extension lecturer, he was in 1891 appointed Secretary for Education to the Devonshire County Council. This post he relinquished in 1894 in order to take up an appointment as an Inspector of Schools under the Science and Art Department. In 1900 Mr. Pullinger was appointed Divisional Inspector and in 1908 Chief Inspector of the Technological Branch of the Board of Education, into which the Science and Art Department had been merged. He was a man of great force of character and possessed a very intimate knowledge of the needs of technical education. The years during which he was Chief Inspector witnessed a rapid growth in the responsibilities of the Board towards technical education, and Mr. Pullinger's wide experience and close association with technical problems were in consequence of very great value. In particular it may be said that he organised an inspectorate containing in its ranks men of expert knowledge in engineering, building, chemical, and other industries, and transformed the whole process of inspection. His death at a comparatively early age is greatly regretted by all who have the future of technical education at heart.

THE death is announced on Christmas Day of the REV. HENRY HOYTE WINWOOD, of Bath, at the age of ninety years. Mr. Winwood was for half a century one of the most active amateur geologists in the West of England, and the stimulating friend of many who have made important advances in geological science. In early life he was associated with Prof. (now Sir) W. Boyd Dawkins and the late Mr. W. A. Sanford in several explorations of bone-caves and prehistoric burial places. In 1865 he announced the discovery of flint implements in definite association with the remains of extinct animals in the cave named Hoyle's Mouth, near Tenby. In his own district he diligently observed all temporary excavations, and made notes which were published in the Proceedings of the Bath Natural History Club. When the British Association visited Bath in 1888 he wrote the section on geology for the local handbook. He also took much interest in the Bath Royal Institution, and collected the fund by which it secured the unique museum of local fossils of the late Charles Moore. He delighted in making this museum accessible for the promotion of research. Mr. Winwood was elected a fellow of the Geological Society in 1864, served for many years on the council, and was a vice-president in 1898–1900 and 1915–17.

THE death of MR. J. G. V. MAIR-RUMLEY on December 20, in his seventy-eighth year, is announced. Mr. Mair-Rumley was a member of the Institutions of Civil Engineers and Mechanical Engineers, and gave much assistance to the research committees inaugurated by the latter institution. His papers contributed to the Institution of Civil Engineers were awarded the Watt medal and a Telford premium in 1881, and a Telford premium in 1885.

Notes.

The New Year Honours Lists which were issued at the end of last week include five barons, five Privy Councillors, twenty-one baronets, sixty-nine knights, and two Companions of Honour. Among the honours we note in particular the following conferred upon men whose names are known in scientific fields:—*Privy Councillor:* The Rev. Dr. Thomas Hamilton, for service to the cause of education in Ireland, first as President of Queen's College, Belfast, and afterwards as President and Vice-Chancellor of the Queen's University of Belfast. *Knights:* Prof. P. R. Scott Lang, for more than forty years Regius professor of mathematics in the University of St. Andrews; Mr. P. J. Michelli, secretary to the London School of Tropical Medicine; Dr. S. S. Sprigge, editor of the *Lancet*; Prof. James Walker, professor of chemistry, University of Edinburgh; and Dr. Dawson Williams, editor of the *British Medical Journal*. *C.M.G.:* Mr. I. B. Pole Evans, chief of the division of botany and plant pathology, Department of Agriculture, Union of South Africa. *C.I.E.:* Lt.-Col. W. F. Harvey, director of the Central Research Institute, Kasauli, Punjab, and Dr. E. J. Butler, formerly Imperial Mycologist, Pusa. *K.C.V.O.:* Dr. F. S. Hewett.

The appeal for help to the scientific and literary community of Russia which we publish elsewhere should meet with a sympathetic response. Since the calamitous political disturbances began in their country many Russian scientific men have taken every opportunity of begging their colleagues and friends in the rest of Europe to help them to emigrate to more congenial surroundings abroad. In very few cases has it been possible to grant their petition. Now that the Bolshevik Government seems to have begun to realise that intellectual life has some value for the nation, it may be best that we should encourage our fellow-workers in Russia to remain at home and give them all possible assistance in promoting learning in the sad circumstances in which they find themselves. We understand that the great libraries, the university laboratories, and the old national collections, at least in Petersburg, are still intact, and that some provision has been made for the small remnant of Russians who are capable of using them. They merely need the stimulus of contact with the centres of intellectual work in other countries and an up-to-date knowledge of the results of research elsewhere. We trust that Britain will take the lead in furnishing this stimulus and supplying the necessary publications to enable Russia again to take a conspicuous place in the world of science, literature, and art.

The Rockefeller Foundation has presented to the State of Louisiana a tract of country comprising some 35,000 acres known as the Grand Chenier Wild Life Refuge (*Science*, December 3). The land was purchased by the Foundation from individual holders in 1914 in order to preserve the wild life of the country, and it is a condition of the gift, which includes laboratories, publications, and equipment connected with the preservation enterprise, that the tract shall remain as a perpetual wild-life preserve.

It is announced that Mr. Llewellyn Treacher has been selected for the Foulerton award of the Geologists' Association.

The Aldred lecture will be delivered at the Royal Society of Arts on Wednesday, January 12, at 8 p.m., by Dr. C. S. Myers, director of the psychological laboratory, and lecturer in experimental psychology, University of Cambridge. The subject will be "Industrial Fatigue." Mr. W. L. Hichens will be in the chair.

Science of December 10 announces that the Elisha Kent Kane gold medal of the American Geographical Society has been conferred on Dr. A. Hamilton Rice in recognition of his pioneer exploratory work in South America; also that the Franklin Institute has awarded the Elliott Cresson gold medal to Dr. W. L. R. Emmet in recognition of his notable contributions to the art of ship propulsion.

Dr. E. O. Teale has been appointed Government Geologist of Tanganyika Colony, formerly German East Africa. Dr. Teale has already had much experience of African geology, having spent several years in Portuguese East Africa, and having been occupied more recently with geological work in Nigeria and Gold Coast Colony. With his former colleague Mr. Wilson he contributed an important paper on Portuguese East Africa to the *Geographical Journal*.

At the exhibition of paintings by the Birmingham Art Circle in the galleries of the Birmingham Royal Society of Artists there will be on view until January 20 two portraits (by Mr. Bernard Munns) which will be of interest to many readers of Nature. One is that of the late Prof. John Henry Poynting, an admirable likeness in which the character of the subject is beautifully expressed. This portrait has been painted for the Trustees of the Poynting Memorial Fund, and will be hung in the guest hall of the University at Edgbaston. The other is a fine portrait of the late Prof. Adrian J. Brown, F.R.S. The University already has portraits by the same artist of the late Prof. Charles Lapworth and Prof. P. F. Frankland.

The results of the balloting in the reorganisation of the International Commission on Zoological Nomenclature have been announced as follows:—*Class of 1922 (elected in 1913):* Dr. J. A. Allen, New York, N.Y.; Dr. F. A. Bather, London; M. Ph. Dautzenberg, Paris; Dr. W. E. Hoyle, Cardiff; Dr. K. Jordan, Tring; and Prof. H. Kolbe, Berlin. *Class of 1925 (newly elected, vice Class of 1916):* Dr. D. S. Jordan, Palo Alto, Cal.; Prof. A. Handlirsch, Vienna; Prof. R. Monticelli, Naples; Dr. E. Simon, Paris; Dr. H. Skinner, Phil., Pa.; and Dr. L. Stejneger, Washington, D.C. *Class of 1928 (newly elected, vice Class of 1919):* Prof. C. Apstein, Berlin; Dr. E. J. O. Hartert, Tring; Dr. Geza Horvath, Budapest; Prof. Louis Roule, Paris; and Dr. C. W. Stiles, Washington, D.C. No majority was obtained for the vacancies caused by the death of Prof. Blanchard and by the resignation of Prof. Roule; accordingly a new vote is being taken. Each class consists of six Commissioners elected to serve nine years, and selected from the zoological profession of the world at large.

AT the annual general meeting of the Faraday Society held on December 13, the following officers and council were elected to serve for the coming year:—*President:* Prof. A. W. Porter. *Past-Presidents:* J. Swinburne, Sir Richard Glazebrook, and Sir Robert Hadfield, Bart. *Vice-Presidents:* W. R. Cooper, Prof. C. H. Desch, Dr. J. A. Harker, Emil Hatschek, Prof. T. M. Lowry, Dr. E. H. Rayner, and Dr. G. Senter. *Treasurer:* Robert L. Mond. *Council:* Dr. A. J. Allmand, Dr. H. Borns, Prof. W. C. McC. Lewis, Harold Moore, Prof. J. R. Partington, C. C. Paterson, Prof. A. O. Rankine, Sir Robert Robertson, Sir T. Kirke Rose, and Dr. W. Rosenhain. Prof. Porter, in proposing a vote of thanks to the retiring president, Sir Robert Hadfield, who had guided the society during the whole critical period of the war, referred to the growth that had taken place in the society's work and in its prestige during that period. He remarked that of the twenty-six general discussions that had been organised by the society, many of them in co-operation with other societies the collaboration of which was greatly appreciated, as many as nineteen had been held during Sir Robert Hadfield's presidency.

THE Report of the Watchers' Committee of the Royal Society for the Protection of Birds for the years 1919–20 is a record of excellent results obtained, but it also reveals how much remains to be accomplished, and could be accomplished if the necessary funds for the purpose were forthcoming. Those at its disposal are wholly inadequate to meet even the expenses already incurred. The society employs twenty-three watchers who are located at seventeen breeding stations annually resorted to by some of the rarer, and hence much persecuted, British birds. Thanks to the loyalty and devotion of these excellent men—they are offered bribes and subjected to threats—it is gratifying to learn that nests of the bittern, Kentish plover, red-necked phalarope, chough, whimbrel, and many other species, including in the south of England the raven and the peregrine, were successfully protected. On the other hand, owing to lack of funds to provide for adequate watching, a lamentable state of affairs is revealed. Thus roseate and Sandwich terns were robbed of all their eggs, and divers, the numbers of which are annually growing fewer, were sadly raided, so that in one case of thirteen nests only three young birds were hatched, while in another out of fifteen nests eight were destroyed. The craze for egg-collecting at the present time is, unfortunately, at its zenith, the excuse being that the specimens are taken for scientific purposes. If scientific results may be derived from the study of the eggs of British birds, it may be safely averred that there is already a plethora of material available for the purpose. It is greatly to be hoped that bird-lovers who are not subscribers to the Watchers' Committee will respond to the society's earnest appeal and help to carry on this highly desirable, patriotic work. The society's address is 23 Queen Anne's Gate, S.W.1.

IN a study of variation in the mealworm, *Tenebrio molitor*, Mr. S. A. Arendsen Hein finds two common colour varieties of the larvæ, chestnut-brown and orange-red, and a rare melanic type with black instead of reddish-brown abdomen, antennæ, and legs. Red and yellow eye-colours are inherited, and the latter is sex-linked. Reduction in the number of tarsal and antennal segments is also based on hereditary factors. The duration of the larval stage is largely controlled by temperature. Females usually produce no eggs without previous mating, and egg-production normally continues for two months.

WE have received vol. vii., part 4 (Series C, Zoology and Botany), of the Scientific Reports of the Australasian Antarctic Expedition, 1911–14, containing the bacteriological and other researches dealing with physiology, dietetics, psychology, etc., by Dr. A. L. McLean. Cultivations from the intestinal tract of some of the mammals and birds (*e.g.* Ross seal and penguins) contain no, or very few, bacteria. Similar results have been obtained in the case of Arctic forms by Levin and others. In other mammals and birds (*e.g.* Weddell seal, sea-leopard, and skua gull) the bacterial content of the intestine was high, containing coliform organisms and sporing bacilli. Cultures of bacteria were obtained from ice, snow, soils, and marine mud. Suppuration was observed in the wounds of Weddell seals, inflicted by the sea-leopard and killer whales, with a bacterial flora of streptococci and staphylococci. Observations on the hæmoglobin values of the blood and on blood-pressure showed little of interest. It was noticeable that the hair of the head and the nails grew very slowly.

VOL. XLIII., article 6, of the Bulletin of the American Museum of Natural History (issued on December 4) consists of an extensive paper on the Lepidoptera of the Congo by Dr. W. J. Holland. It takes the form of a systematic list of the species of that order of insects collected during the expedition sent out by the museum to the Congo region. Although the collection is one of the largest made in recent years in that part of the world, it is very poor in moths, most attention being devoted to the showier Nymphaline and other butterflies. As Dr. Holland points out, the primary aim was to secure vertebrates, and the making of insect collections was a subsidiary object. From among about 9000 specimens there are more than 725 species and varieties. It has only been found necessary to erect two new genera, and the new species and varieties amount to fewer than 80. The largest number of specimens was secured at Medje, near the Nepoko River, in the heart of the forest, from April to September, 1910, and the collection as a whole exhibits a distinct affinity with the West African fauna. The paper is evidently an important contribution to our knowledge of the distribution of Lepidoptera in Africa, and is illustrated by nine three-colour-process plates and a similar number of text figures.

AMONG the creatures that live harmoniously with termites in their nests is a Staphylinid beetle, which, like the familiar "devil's coach-horse," turns its abdomen over its back, but in this case the abdomen is greatly swollen, stretches far forward, and is extended backwards only with difficulty. This beetle, previously referred by Dr. E. Warren to the South American genus Corotoca, has now been more closely investigated by him, and is redescribed as *Paracorotoca akermani* (Ann. Natal Mus., vol. iv., pp. 297–366, pls. xvi–xxi, November, 1920). Dr. Warren finds that, structurally, it is closer to the Malayan Termitoptochus, and infers that the resemblances to Corotoca and other termitophilous beetles are due to the similarity of their environment. Paracorotoca has been found only in nests of the common Eutermes (*E. trinerviformis*) of Natal, and is very rare. The inflated abdomen is almost filled with the greatly overgrown sexual organs. The ova are relatively huge, and this is probably connected with the viviparous production of large larvæ. No similar need exists for the large size of the male organs, and it may be supposed that the stimulus for their growth has been transmitted to the male from the female. How far the termites feed the beetles and in what way the beetles repay the hospitality are questions not yet settled. One curious observation has been made: when termites are alarmed they vibrate their bodies in a characteristic manner, and the beetle does the same. Dr. Warren compares the habit in the termites to the trembling with rage or fear in mammals, and suggests that the intimate association of the beetle with the termites has produced in it a similar nerve-tone.

THE *Journal of the Ministry of Agriculture* for October and November, 1920, contains an interesting account of the work of the new Plant Breeding Institution at Aberystwyth by the director, Prof. R. G. Stapledon. In addition to the laboratories, which are now completed, there is a drying-room and a gardeners' room designed for the threshing and cleaning of small lots of seeds. The land attached to the station includes 4 acres of garden-ground, a 13-acre field of arable land for larger trials, and an adjoining farm of 92 acres. One of the chief problems taken up is that of the improvement of herbage plants for the grassland areas of Wales and the West of England. Of the numerous grasses and legumes being tried the following already show promise: *Phalaris nodosa*, a rich pasture grass from South Africa; *Danthonia pilosa*, from New Zealand; *Eragrostis abyssinica*, which produces hay in portions of Natal and the Transvaal; *Trifolium subterraneum*; and the hairy vetch, *Vicia villosa*. Local indigenous grasses are also being brought into cultivation with the view of improving strains which are already adapted to the conditions. Cocksfoot grass from various countries was grown, and the indigenous plants were found to show greater development and to have the advantage of being later. Experiments are also being taken up with cereals, particularly oats, for high elevations and high rainfall.

THE possibility of recognising shoals and channels from a photographic print and of determining in some measure the shape of submerged land-forms opens a new avenue of approach to the study of submarine geography by the use of aerial photography. The subject is discussed by Dr. W. T. Lee in an article in the *Geographical Review* for November (vol. x., No. 5). A number of finely reproduced photographs by the Air Service of the United States Army illustrate the extent to which the camera succeeds in recording submarine features. Experience seems to show that the best results are likely to be obtained early in the morning or late in the afternoon under an evenly illuminated sky. Either an entirely overcast or a uniformly clear sky is more favourable than a partly clouded sky. Waves appear to have little effect on the visibility of submarine relief, but by the diffusion of reflected light they can at times destroy the effect of the detail on the photographic plate. More research, however, is necessary in order to decide the best conditions for determining clear detail.

THE recurrent subject of the growth of flint is revived by Mr. C. Carus-Wilson in a letter to the *Geological Magazine* for October, where a case is quoted of the inclusion in flint of wood bored by Teredo. The problems that this specimen justly raise in Mr. Carus-Wilson's mind could probably be set at rest, as in other cases referred to, by thin sections cut from the encasing flint, and it is to be hoped that the matter will be pursued further.

MR. S. S. BUCKMAN's work on "Type Ammonites," finely illustrated by photographs of actual specimens, has reached its twenty-third part, and is already a monument to the painstaking devotion of its author. We fear that questions from other workers as to generic subtleties must make serious inroads on Mr. Buckman's time, since we cannot now think of British ammonites without him. The work is published for the author by Messrs. W. Wesley and Son, Essex Street, London, W.C.2.

TABLES of frequencies of surface-wind directions and cloud amounts at Metz, Mulhausen, Karlsruhe, and Fránkfort by Capt. D. Brunt have been published by the Meteorological Office as Professional Notes No. 14. The tables are similar to those given previously for Richmond and Greenwich. They are based on the observations from the German Daily Weather Reports for ten years, 1900–10, excluding 1906. The results are said to differ widely from those for Richmond, where the number of clear skies in the summer is much greater in the evening than in the morning, but the tables in the present publication show only a very slight clearing in the evening in the summer, and in July the evenings are cloudier than the mornings. For the towns dealt with, the most frequent wind directions are north-east and south-west. North-east winds divide into two groups, with clear and overcast skies respectively, and in the summer they give more clear skies in the evening than in the morning, the cloudiness of the weather being apparently controlled by the different weather types. South-west and west winds are said usually to be associated with the passage of depressions across the British Isles, tending to give overcast skies, especially during the morning. They are associated with a greater frequency of clear skies in the evening during the months of September and October. Pilot-balloon results show that at Aix-la-Chapelle

(Aachen) and Frankfort the direction of the wind at the surface is practically the same as at an elevation of 1000 metres, while at Strasbourg the wind at the surface is usually backed two points from the wind at 1000 metres.

WHEN the interpretation of crystal structure on the basis of close-packed spheres was put forward by Barlow and Pope in 1906 it was suggested that the sphere of influence of each atom in a given crystal was approximately proportional to its valency, but that these spheres of influence varied in size in a series of isomorphous crystals in such a way as to preserve the proportionality of their individual volumes to the valencies, whilst the sum of their volumes varied with the molecular volume of the compound. Prof. W. L. Bragg's study of the structure of crystals by means of X-ray analysis, on the other hand, led to the conclusion that each atom has a constant sphere of influence, the atomic diameters of some of the common elements being, for instance, as follows:

F = 1·35 Å.	O = 1·30 Å.	Li = 1·50 Å.	Be = 1·15 Å.
Cl = 2·10	S = 2·05	Na = 1·77	Mg = 1·42
Br = 2·38	Se = 2·35	K = 2·07	Ca = 1·70
I = 2·80	Te = 2·66	Rb = 2·25	Sr = 1·95
		Cs = 2·37	Ba = 2·10

A crucial test of these alternative views can be made most readily by carrying out an X-ray examination of an isomorphous series, and this has now been done in the case of calcite and the isomorphous carbonates of manganese and iron, the Laue patterns from which have been analysed by a novel geometric method by R. W. G. Wyckoff (*American Journal of Science* [iv], vol. l., pp. 317–60, November, 1920). The following results were obtained:

	$CaCO_3$	$MnCO_3$ (and $FeCO_3$)
Distance from carbon to oxygen	1·21 (1·42)	1·22 (1·42)
,, ,, ,, metal	3·04 (2·47)	2·83 (2·24 and 2·17)
,, ,, oxygen ,,	2·30 (2·35)	1·96 (2·12 ,, 2·05)

In this table the distances from carbon to oxygen are constant, whilst the distances from carbon to metal and from oxygen to metal are about 0·26 Å. and 0·34 Å. greater for calcium than for manganese and iron. It should, however, be noted that most of these data differ considerably from those given by Bragg (which are shown in brackets in the table), the deviations rising to 0·6 Å. in the distance from carbon to metal, *i.e.* nearly three times as much as the variation on passing from calcium to manganese or iron.

IN *Science* for October 15 Mr. J. J. Willaman, of the University of Minnesota, directs attention to the possibility of utilising artichoke and dahlia tubers as sources of fructose, which could be used, in place of ordinary sugar (sucrose), as a sweetening agent. These tubers contain the carbohydrate inulin, which on hydrolysis by acids is converted into fructose (lævulose), just as starch is similarly convertible into glucose (dextrose). Taking an average crop of artichoke tubers at 40,000 lb. per acre, and assuming a recovery of 10 per cent. of inulin, Mr. Willaman states that it should be possible to obtain about 4000 lb. of fructose per acre, which is nearly equal to the yield of sucrose from a good crop of sugar-cane and about twice the yield of glucose syrup from an average crop of maize; fructose, moreover, is sweeter than either sucrose or glucose, so that artichokes would appear to have a distinct advantage over either sugar-cane or maize as a source of sweetening material. The author realises that the matter may not be quite so simple as it looks, and he appeals for the inauguration of research by some official or industrial organisation to ascertain whether a presentable fructose can be made from artichokes. These tubers have been used in Germany as a source of alcohol, but that is a simpler proposition than the manufacture from them of a serious competitor with cane-sugar. Artichokes grow well in England, as hundreds of allotment-holders discovered during the war; there are plenty of British chemists familiar with the chemistry of carbohydrates, and our large consumption of sugar is met almost entirely by imports. In view of this, the Department of Scientific and Industrial Research might do worse than take Mr. Willaman's suggestion into serious consideration, if it has not already done so, and, if there is anything in it, arrange to have the necessary research work done in this country.

WE have received a Physical Department Paper issued by the Egyptian Ministry of Public Works on "The Effect of Turbulence on River-discharge Measurements," forming an addendum to a Report on Nile Gauge Readings and Discharges published in March last. Mr. Hurst, Controller of the Physical Department, has prepared this note to prevent any misconception which might arise on the statement of certain views attributed to Mr. Craig, of the Egyptian Survey, in the earlier publication. The Survey of Egypt carried out a long series of river-discharge measurements at Sarras, in the Sudan, the results of which, after making all necessary allowances, showed a considerable divergence from the readings at the Aswân Dam, amounting to about 15 per cent. In 1912 Mr. Craig put forward the suggestion that the variation might be due to the effect of turbulence in the flow, and showed mathematically that reductions in apparent volume might have to be made amounting to as much as 20 per cent. during flood and to 10 or 15 per cent. when the river was low. Experimental investigation, however, has demonstrated that the correction for turbulence at the low stage of the river is negligible. After alluding to some further experiments now being carried on, the paper concludes:—"The effect of turbulence at the low stage is now settled, and the probability is that the amount of turbulence present in the Nile in flood at well-chosen sites will not necessitate any corrections of practical importance. The cause of the difference between the discharges at Sarras and Aswân still remains to be found."

WE have received from Messrs. J. Woolley, Sons and Co., Ltd., of Manchester, a copy of their "Scientists' Reference Book and Diary," price 3*s*. 6*d*. The book contains much interesting and useful information in addition to that usually found in diaries. The first section deals with the physical sciences, and contains a short article on recent advances in physics; another portion is devoted to chemical tables, and includes convenient data relating to specific gravities, solubilities, strengths of solutions for analysis, etc. A section is also devoted to scientific societies and departments, in which a brief account is given showing the address and the officials of each. The diary is well bound, and makes a convenient pocket-book for ready reference and notes.

MESSRS. H. F. AND G. WITHERBY are about to publish vol. i. of "A Manual of the Birds of Australia," edited by G. M. Mathews and T. Iredale, illustrated by coloured and monochrome plates.

A NEW edition of Sir Edward Thorpe's "A Dictionary of Applied Chemistry" is announced by Messrs. Longmans and Co. Vol. i., A to Calcium, is promised for January, and vol. ii. for early in the coming summer. The work, which has been carefully revised, will be in six, and possibly seven, volumes.

Our Astronomical Column.

COMETS.—Mr. Woods has communicated by cable the following elements of Skjellerup's comet. Elements deduced by M. Ebell from observations on December 13, 17, and 18 last are also given. Both are for the equinox of 1920·0:

	Woods	Ebell
T in G.M.T.	Dec. 11·11	Dec. 13·46512
ω	341° 10′	344° 9′ 47″
☊	107 47	107 38 7
i	22 12	24 4 7
log q	0·06047	0·06476

Mr. Woods's elements make the position at midnight on January 20: R.A. 11h. 7m. 17s., N. decl. 36° 22′. The position given last week was: R.A. 11h. 17m. 42s., N. decl. 38° 24′.

Herr Hoffmeister observed the comet at Sonneberg on December 18. He described it as a circular nebulosity 8·0′ in diameter, total light 9th magnitude, nucleus 11th magnitude.

An observation by Mr. R. L. Waterfield on December 31 indicates that Mr. Woods's ephemeris is very near the truth.

The two longest-known comets of short period (those of Encke and Pons-Winnecke) are both due at perihelion in 1921. There is a simple method of predicting the date of perihelion of the former comet within a day or so. Eighteen revolutions of the comet occupy $59\frac{1}{2}$ years, equal approximately to five revolutions of Jupiter and two of Saturn, so that the perturbations nearly repeat themselves after this period. The following have been the duration of eighteen revolutions at recent returns:

	Interval (days)		Interval (days)
1845 to 1905	21704·28	1855 to 1914	21705·75
1848 to 1908	21704·08	1858 to 1918	21705·92
1852 to 1911	21705·33	1862 to 1921	21706·1 about

Perihelion should occur about July 13·4.

Winnecke's comet is subject to large perturbations by Jupiter, and no simple cycle is available in this case. The best estimate that can be made of the date of perihelion is the end of June, but this may be a month in error. The period of this comet has increased by four months in the last century, and the perihelion distance has increased from 0·77 to unity. This has resulted in introducing it into a new shower of meteors, first seen on June 28, 1916, the connection of which with Winnecke's comet was quickly detected by Mr. Denning. These meteors should be in evidence next June. The radiant is about 240°+50°.

Another periodic comet may return this year, 1846 IV (de Vico). The most probable period is 75·7 years, which would make the next perihelion November, 1921, but the uncertainty is fully three years. The comet will first become visible to southern observers, but it will move northward very rapidly, its inclination to the ecliptic being 85°.

DISAPPEARANCE OF SATURN'S RINGS.—The earth passed through the plane of the rings on November 7, and a joint paper on the phenomena presented about that date, by Messrs. Hepburn, Ainslie, Steavenson, and Waterfield, was read at the R.A.S. meeting on December 10. They observed with the 28-in. equatorial at Greenwich, by kind permission of the Astronomer-Royal. On November 6 the ring was easily visible, but on the following night no trace whatever was visible outside the ball. This was confirmed by Prof. Barnard, observing with the 40-in. at Yerkes Observatory, who estimated that the thickness of the rings could scarcely exceed 40 miles. A few days later, in spite of the dark side of the rings being turned towards us, the observers at Greenwich could clearly see a number of luminous patches outside the ball, which they were able to identify with the brighter regions of the ring; they noticed that these regions continued visible when twilight was far advanced and long after the inner satellites had disappeared. This would appear to indicate that an appreciable amount of sunlight is able to penetrate the ring, illuminating the particles on its remote side. It will be remembered that a star was recently seen through the ring, so it is not surprising that sunshine should penetrate it.

The ring will again be edgewise to the earth on February 21 and August 2, and to the sun on April 10.

KODAIKANAL OBSERVATORY.—Bulletin lxiii. of this observatory deals with the direction and aspect of the dark filaments which are such a conspicuous feature of spectroheliograms in Hα light, and are known to be prominences projected on the solar disc. Their azimuth is first studied, and shown to be a function of latitude. Near the equator they lie along a meridian; as we recede from the equator the polar end of the filament swings eastward. The mean inclination to the equator is 40° in latitude 30°, and 0° in latitude 60°.

The explanation suggested is the easterly drift produced by the excess of easterly motion at the equator. It was inferred from this that the high-latitude filaments are older than the equatorial ones. However, a study of the history of particular filaments from the photographic records did not give clear evidence of this difference of age with latitude.

Two interesting features of the prominences are discussed: (1) Those on the disc are flanked by a bright strip, which is easiest to see near the limb. It is interpreted as showing that the prominences rest on a bright base which is hotter than the ordinary chromosphere. (2) The lower portion of prominences seen in profile outside the disc is frequently obscured by a dark strip. It is suggested that the central region of a prominence is the hottest, and that the lower portions of the cooler outer envelope may be dense enough to absorb light.

Birth and Growth of Science in Medicine.[1]

By Sir Frederick Andrewes, F.R.S.

The aim of science is to discover the "laws of Nature," and in its truest, though narrowest, sense it is the pursuit of this knowledge for its own sake, irrespective of any practical use to which it may be put. The primary aim of medicine is the practical one of healing the sick or of preventing disease, and therefore, in the narrower sense, medicine is not a science, but an art. Physiology, pathology, and pharmacology are sciences in the strictest sense; medicine is the art of applying the laws established by these sciences to the prevention or cure of disease. More than this, it is the very human art of treating the patient as well as his disease. But in a broader, and surely more natural, sense we may regard medicine as a science. Pathology may, it is true, be pursued as an abstract subject, but in real life it is inseparable from medicine. Treatment and prevention are so intimately based upon a right understanding of the nature of disease and of the laws which govern its course that I refuse to separate pathology and medicine. It has too long been the fashion to limit the sphere of pathology to the dead-house and the laboratory; its field is equally at the bedside, and, indeed, I would assert that there is no method of studying the natural history of disease which pathology may not claim as its proper province. By Harvey's injunction I am to admonish you to seek out the truths of Nature by observation and by experiment. These are two different ways of pursuing a subject, and, indeed, the concrete sciences have been divided into the "observational" and the "experimental"; anatomy is an observational science, physiology an experimental one. The observational sciences long preceded the experimental, and in pathology and medicine, which partake of the nature of both, the experimental method is of late growth.

My aim is to trace, so far as I may in the allotted span of time, the influences which have governed the growth of our knowledge of disease; to pursue them to their beginnings rather than to record their final results. I cannot, indeed, hope to say anything new; I can only endeavour to place before you the facts to be gathered from literature in the way in which they group themselves in my own mind.

In his suggestive little book entitled "The Revolutions of Civilization" Prof. Flinders Petrie has pointed out that culture is an intermittent phenomenon. No civilisation in the past has proved permanent, and he estimates the average duration of any given period of culture at about 1500 years; in Egypt he traces eight such periods. In Europe we are aware of three great periods of civilisation during the past five thousand years—the Mediterranean or Minoan, with its headquarters in Crete, from 3000 to 1200 B.C.; the Classical, of which Greece was the intellectual fountain-head; and the Modern or Western, in which we are still living.

So far as we are aware, the earliest attempts at science began in Ionia some six centuries before Christ, and the name which I would first commemorate as a spiritual benefactor of this college is that of Thales of Miletus. I might have chosen Empedocles or Pythagoras, but we may let Thales, as the first of the succession of early Greek thinkers, stand as the prototype of the group of men who laid the foundations upon which science was to be built by future generations. Doubtless they had acquired what they might of the lore of older civilisations, but they seem to have been the first to pursue abstract knowledge. Until their day men had been content to accept any foolish myth about the nature of the world and of the things they saw around them. The service which Thales and his successors rendered to mankind was that they rejected all fabulous tales and began to think for themselves how things had become such as they saw, definitely reaching out after the laws which they felt sure must govern Nature. Their great contribution to science was to establish that atmosphere of intellectual liberty which rendered science possible. It says much for the liberal spirit of that age that these men, who broke with all the cherished traditions of the past, were not, as a rule, reviled for impiety, but received universal honour. Thales was accounted one of the Seven Wise Men of Greece.

But let me now consider what the earlier Greeks did for medical science. Medicine of a sort and rude surgery must have been transmitted even through the dark ages, handed down, it is said, by special families, the Asklepiadæ, just as the epic tradition was passed along by the Homeridæ. Certain rules of surgery and the practices of blood-letting and purgation are known to be of immemorial antiquity, but for the most part the medical practice of those times seems to have been bound up with fetish worship and superstition. There is no evidence that Egypt had any true medical science to impart, and our knowledge of Minoan medicine is limited to the single fact that in the great palace at Cnossus there existed a system of sanitation so good that it was never equalled until the reign of Queen Victoria. We may be quite sure that the inquisitive and receptive Greek mind was quick to pick up what it could from the older civilisations, and then, in accordance with its peculiar genius, it proceeded to develop it out of all recognition.

Medicine entered upon its first scientific stage with the Greeks; it became an observational science. More than this; just as in other matters the philosophers had put away the myths and fairy tales of their ancestors, so, too, in medicine they rejected the magic and fetish worship which had hitherto formed so large a part of practice. This was one of the greatest services rendered by the Greeks to medical science. Æsculapius was worshipped at numerous temples, and thither the sick were brought to receive such benefit as they might from the rites of the god. But at such health resorts they were also subjected to other influences—careful diet, pure water, rest, and cheerful associations—and when improvement occurred the physicians had the acuteness to perceive that this simple treatment had probably more to do with the result than the religious rites.

This brings me to the second name which I naturally commemorate to-day—that of Hippocrates of Cos—the first great clinician of whom we have any knowledge, and one whose name will always be associated with the phase which Greek medicine had now reached.

When Hippocrates was born, about 460 B.C., observational medicine had attained a considerable pitch of excellence. He doubtless imbibed the teachings of other good physicians who had gone before him, but the veneration in which Hippocrates was held by the Greeks themselves assures us that he was a man of outstanding character and attainments. We can,

[1] From the Harveian oration delivered before the Royal College of Physicians of London on October 18, 1920.

however, judge of him more directly. It is certain that only a small part of the Hippocratic treatises which have come down to us are from the pen of the master himself, but we may reasonably take them, as a whole, to represent his teaching, and they give us a fair idea of the stage at which the best Greek medical science had arrived in the fifth century B.C. It was a simple and rational medicine based on careful clinical observation and on a watchful study of the results which followed hygienic treatment. The healing powers of Nature formed a leading tenet of the Coan school; we may almost regard Hippocrates as the founder of sanatorium treatment. Perusal of those of the Books of Epidemics which are most certainly by Hippocrates himself shows that he was an admirable case-taker; in the light of our present knowledge we can readily make a diagnosis from many of his descriptions. His medicine shows, of course, the natural limits of a purely observational science; it knows little of anatomy and less of physiology; its crude pathology is based on the doctrine of "opposites"; the idea of experiment as a means of investigation has not yet arisen. Yet in spite of this, the school of Cos is a landmark in the history of rational medicine.

The centre of interest now shifts elsewhere, and especially to Alexandria, but it remains Greek. Alexandrian culture represents a sort of continuation of that of Athens, though, perhaps, in comparison smacking somewhat of Wardour Street. The great creative age in art and poetry had gone by; it was a period of imitation in art, and in literature largely a time of scholiasts and commentators on the better work that had been done before. But here we have an excellent illustration of Prof. Flinders Petrie's dictum that in each period of culture science reaches its prime long after art and literature have begun to decline. For all the branches of science then extant continued to advance in Alexandria. I need scarcely recall how mathematics and astronomy flourished under the Ptolemies, and in medical science the Alexandrian school maintained its premiership for many hundred years.

Anatomy and physiology form a necessary basis for medical science, and much as the earlier Greeks had done for medicine, they had lacked any adequate knowledge of these subjects. The later Greeks proceeded to remedy this defect. The practice of dissection became established, and anatomists must look back to the Alexandrian school for the foundation of their science. I must pass over Herophilus and Erasistratus and commemorate the later Greek school in the person of its most distinguished alumnus, Galen. Roman medicine, like its art, was wholly Greek in origin; its great physicians received their training in Greek schools, and Celsus, the best-known writer on medical subjects, was not himself a practitioner of medicine. Thus, though we associate Galen with Rome, I must commemorate him as a Greek—the last and, in many ways, the greatest of the Greek physicians.

Nearly six hundred years had passed between Hippocrates and Galen, and when we compare the two it must be remembered that Galen had the advantage of that six hundred years of medical experience. It gave him a wider outlook, and thus made him a better physician, though I conceive Hippocrates, considering his times, to have been the bigger man. I do not propose to dwell on Galen's eminence as a physician, though he stood far above all others of his age. His real claim to immortality may be put into a few words: he was the first to make systematic use of the experimental method in medicine, and he founded the science of physiology. His experimental discoveries in physiology, and particularly in the domain of the nervous system, entitle him to be called the father of that science. Galen must also be credited with a great advance in pathology. The earlier Greeks had regarded internal medicine from a purely humoral aspect; the later Greeks began to recognise affections of certain definite organs, but Galen developed this conception beyond any of his predecessors.

With Galen we come to the end of the great age of classical civilisation, and it will be fitting, before leaving it, to summarise what Greek genius had accomplished in medical science. An atmosphere of intellectual liberty essential to the birth and growth of science had been established by the Greeks; they had developed the love of knowledge for its own sake. Their shrewd observation had transformed medicine from a medley of traditional empiricism and superstition into a natural science; they freed it from magic and laid the foundations of a rational treatment of disease. Towards the close of their epoch they devised the experimental method, and used it to found the science of physiology. Indirectly we owe to them the laws of clear thinking in medicine and in the other sciences, and the development of mathematics and mechanics.

When the Minoan civilisation passed away the Greeks had been compelled to begin again almost from the beginning. There was no such complete break between the classical period and our modern civilisation; much was handed on by direct tradition, and vastly more by written manuscript. Nevertheless, after the fall of the Roman Empire, Europe had to be remade, and to pass through its dark ages before the dawn of a new culture. The new mixture of races seems to have been incapable of intellectual achievement until the ordained incubation period was over, and that period was at its darkest from the fifth to the tenth centuries A.D. Medicine shared the fate of the other sciences, and what was not forgotten became debased by admixture with Eastern magic and superstition.

The dominant power in Europe during this period was the Church, and, although its conservatism had a wholly deadening influence as regards the advance of science, it did much to preserve the culture of classical times. In the seventh century occurred the last of the four known Arab migrations which have overwhelmed neighbouring peoples; it spread not only over Western Asia, but also round the Mediterranean. Whatever may have been the primitive culture of these Arab invaders, they presently acquired a high degree of civilisation. They were a keen-witted race, quick to assimilate the culture with which they came in contact, and this was largely Greek in origin. For some hundreds of years the Moorish Empire in Spain was far in advance of the rest of Europe in literature, in science, and in medicine. The best medical works of classical antiquity were translated into Arabic, and it is by this strange route that much has come down to us which would otherwise have been irretrievably lost. Their chief share in medicine was to absorb and transmit the knowledge of the Greeks. Medicine reflects the spirit of the Dark Ages in Europe; the traditions of the past were still supreme, and Galen was the god of the medical world. Men felt him to have been a better man than themselves, as in truth he was, and it was enough that Galen said this or that, or that his writings could be interpreted in such and such a sense, and there the matter ended.

Then, in the fullness of time, after more than a thousand years of intellectual slumber, men again began to think for themselves, just as the Ionian Greeks had done twenty centuries before. The Renaissance was at first literally a revival of learning, due to the renewed study of the Greek language and the discovery of much of the classical literature which had been hidden away in the libraries of the East. The first effect of the revival was to strengthen the position of Galen. With the revival of Greek in the fifteenth century his original writings became accessible, and manuscripts hitherto unknown came to light. It became the aim of the scholars of the time to translate these works into polished Latin for the benefit of those unacquainted with Greek. Amongst the medical humanists, as they are termed, was the founder and first president of this college. There is no more honoured name in scholarship than that of Linacre, but it is instructive to note the difference between his mental attitude and that of Harvey, little more than a hundred years later. Linacre stands for the revival of learning, Harvey for the intellectual quickening that revival was to engender. The avowed aim of the medical humanists was not the advance of medical science, but a return to the uncorrupted knowledge of the Greeks; the thought and science of antiquity were still held so immeasurably superior to anything that modern times could produce that no advance was contemplated. But the seed was sown. Greek literature was the product of an original creative activity and a mental freedom to which Europe had been long unaccustomed. Men could not study it without at the same time drinking in something of the spirit in which it had been conceived and which animates it for all time. This was our true heritage in the Renaissance, and once again imbued with this spirit men felt at liberty to ask whether the ancients were always right and to criticise and test their statements. The reign of mere authority came to an end, and science recommenced that advance which has continued to the present day.

The first science to bear new fruit was anatomy. It was in Italy that the resurrection began, and the book written by Vesalius on "The Structure of the Human Body," published in 1543, set the seal upon the new method—the appeal to fact instead of to dogma. We all know that the truth as to the pulmonary circulation was first ascertained, while it was reserved for Harvey to demonstrate the systemic circuit. The method of experiment as an adjunct to observation, instead of being delayed for hundreds of years, as it had been amongst the Greeks, was now, thanks to Galen, an instrument ready to hand. And thus it came about that when a man arose deeply imbued with the true spirit of science and capable of using this instrument with intelligence and an open mind, his study of the circulation was at once rewarded by a discovery of capital importance.

William Harvey stands as one of the landmarks in the history of medical science. His was the first scientific discovery of absolutely first-rate importance to be made by the application of the methods and spirit now revived from ancient times; he possessed the vision, the power of imagination, as well as the needful industry and patience in gathering his facts and in devising his experiments.

Harvey has left us two treatises of unequal greatness. The "De Motu Cordis" has no need of any introductory disquisition on scientific method, for it itself is the method incarnate. It is the mature work of a master who is sure of his ground; it sweeps us along from one short chapter to another, each filled with accurate observation and close reasoning, so that no doubt or hesitation is possible to the reader.

But he also essayed to solve other biological problems, for which his means were not adequate, and the "De Generatione," which he was reluctant to publish, is reading of a different kind. The most instructive part of this treatise is perhaps the introduction on scientific method, "Of the Manner and Order of Acquiring Knowledge." Here Harvey in his later age sets forth the principles which had guided him, with Aristotle as his leader, in his life's work, and we realise how truly scientific were his methods.

With Harvey, we feel that medical science has fairly entered the right path. The conditions essential to scientific progress—freedom of thought, accuracy of observation, imagination, experimental verification, and logical reasoning—all are exemplified in Harvey's work.

There is room for difference of opinion as to the impulses from external sources which have had the most far-reaching effects upon medicine since Harvey's day, but I would name four as of exceptional importance. They are the invention of the compound microscope, the development of chemistry, the acceptance of the doctrine of evolution, and the discovery of the relation of micro-organisms to disease. The microscope was invented in Holland late in the sixteenth century, but its possibilities as an aid to anatomy were not at first grasped, and it was not until after Harvey's death that Malpighi actually saw the capillaries and the contrary direction of the blood-flow in arteries and veins. The rise of histology from that time forward has transformed our ideas of the structure of the body, and with each improvement in the microscope our horizon has widened. We have passed from the organ to the units of which it is built up, and Virchow's "Cellular Pathology" marks an epoch in medicine. To-day we are a stage further, for the inquiry is being pushed into the more intimate structure of the cell itself, in the hope of revealing the nature of the processes by which it carries on its work.

The rise of physics and chemistry has been even more fruitful for medicine. We cannot nowadays consider them separately, so closely merged have they become. We recognise the fundamental importance of these sciences for the right understanding of physiology and pathology by placing them at the root of medical education.

Chemistry has influenced medicine from the days of alchemy onwards; Paracelsus and Van Helmont stand out as picturesque figures in its history. In England the rise of physics and chemistry began in Harvey's lifetime with those meetings of scientific men which later gave birth to the Royal Society. It must not be forgotten that the work of such men as Boyle, Hooke, Lower, and Mayow practically solved the problem of respiration not long after Harvey's death—a problem second only in importance to that of the circulation—though a century was to elapse for its full meaning to become clear with the discovery of oxygen. Every advance in physics and chemistry has borne fruit for us in its turn; to-day we can almost affirm that the chief issues in physiology and pathology are to be sought in the chemical activities of the human body. These, again, are bound up with physical conditions, and there is one recent branch of chemistry the possibilities of which are only beginning to be appreciated in medicine. If we reflect that the body, from a chemical point of view, consists almost entirely of colloids, the behaviour of which is still imperfectly understood, it will be realised that advances in colloidal chemistry are destined to throw a flood of light upon the processes of vital activity.

The doctrine of evolution has scarcely received the attention it merits as a factor in modifying the opinions of medical science. So long as it was believed that the body, with all its natural functions, had been created from the first in its present condition, there was little room for inquiry into the origin of those functions, and still less into that of morbid processes. Darwin has changed all this, as a single instance will suffice to show. Metchnikoff's studies on the comparative pathology of inflammation have taught us that this is not a diseased state, but a purposeful reaction against injury, gradually perfected in passing up from the lower to the higher animals. Almost without our being conscious of it, the idea of evolution has gradually effected a great change in the point of view from which we regard a large number of diseases, the symptoms and morbid changes in which we now understand as efforts of the body to maintain its integrity in face of the injurious agencies which threaten it. One might almost rewrite pathology from the evolutionary point of view

Last, but not least, of the great changes which have swept over medical science is that which was due in the first place to Pasteur, carried on by Koch, and brought to triumphant practical application by Lister. The discovery of the true nature of infection has of necessity transformed the outlook of medicine and surgery, but bacteriology and its daughter science immunology would demand a Harveian oration to themselves.

We loosely speak of such fundamental discoveries as those I have just mentioned as producing a revolution in medical science. It is not revolution, but upward growth. With the establishment of each great principle we gain a fresh height from which the field of science takes on a new and wider aspect, and we may be confident that we shall reach yet greater heights to reward us with an even ampler range of vision. There is no sign that the vitality of science in our civilisation is in any way spent; on the contrary, its fertility is unchecked. During the late war we saw for the first time the scientific forces of this country fully mobilised, and no previous five years have seen so many scientific problems brought to a successful issue. So forcible has been the lesson that science has gained mightily in public estimation, and research is on the lips of everyone. New facts are being gathered in, old facts are coming to be seen in a new light; we are almost bewildered by our own progress. The workers in the field of medical science are many, and it may not be given to any one of us to make an immortal discovery, such as that of the circulation of the blood. But the humblest of us can work in Harvey's spirit and bring his contribution to the building up of knowledge in the full assurance that even a single stone, if honestly and truly squared, will in due time find its proper place in the fabric.

Wheat from Seed-bed to Breakfast-table.

"THE History of a Grain of Wheat from the Seed-bed to the Breakfast-table" formed the subject of the concluding evening discourse given by Sir Daniel Hall at the Cardiff meeting of the British Association, and an account of it appeared in the October issue of the *Journal of the Ministry of Agriculture*. Of all industries there is not one which is older, more universal, or more essential than the growing, grinding, and baking of wheat and its kindred food-grains. Yet, in spite of the extreme age of the industry, the various processes involved in the passage of the wheat-grain from its seed-bed to the breakfast-table still demand the close attention of the best obtainable research men of the day; for it is only by research and by the utilisation of the results so obtained that the increased food production necessary for supplying the needs of the world's growing population can be attained.

Many experiments have been made to try to bring about an increase in yield by treating the seed either by electricity or by soaking it in some nutrient fluid. The results of these experiments are very doubtful, and it is improbable that such treatment can affect the ultimate yield. Attention has also been paid to the influence on the wheat yield of the rate of sowing. Ordinarily, wheat sown at the rate of 2½ bushels per acre gives a thirteenfold yield, but isolated wheat-plants are capable of giving more than a hundredfold yield. It is hoped that by using a suitable machine a perfectly effective seeding can be attained with 1 bushel per acre, and such a reduction in the amount of seed sown would mean a considerable gain to the country. Improvement in the quality of wheat grown has been brought about by careful breeding work. Prof. Biffen, working on Mendelian principles, has obtained a variety of wheat, "Little Joss," which produces very good crops on certain soils because of its resistance to rust attacks, the rust-resistance power having been introduced into the grain by careful selection and breeding. Another wheat, "Yeoman," has been bred for the high milling quality of the grain, and on soils to which it is suited the "Yeoman" wheat yields a very heavy crop, while the quality of the flour is almost equal to that obtained from the best Canadian grain. At the present time millers are compelled to mix strong foreign wheat with our home-grown wheat in order to produce bread of the spongy type desired by the public, but it is hoped that extension of Prof. Biffen's work will ultimately supply strong wheats of the "Yeoman" type suited to the varying conditions of all our different wheat-growing districts, and in this way the millers may be rendered independent of foreign wheats.

Although wheat is *the* crop for breaking in virgin land, yet it will not stand competition; at Rothamsted a wheat crop left unharvested to sow itself without further cultivation entirely disappeared in a grassy wilderness in three years. Wheat, though thus dependent on cultivation, possesses a remarkable power of yielding a good crop upon all sorts of soil. One of the Rothamsted plots has carried wheat for seventy-seven successive years without any manure, and the yield is still about 12 bushels per acre—approximately the average crop for the wheat-lands of the world. The manurial requirements of a wheat crop have long since been decided, and the problem now is to prevent the lodging which occurs with big crops on good soils. It may be possible to breed varieties with stiffer and shorter straw, or it may be that manurial treatment, time of sowing, width of rows, and spacing of the seed have some effect on the lodging, or, again, there may be some actual disease factor involved. All these points are being investigated.

The growth of the wheat-plant, so far as gathering material from the air and from the soil is concerned, is practically completed about five weeks before the grain is harvested. This latter period is occupied by the transference of stored-up food from the leaves and stem to the seed. The transference, however, is never complete, and the straw still retains about half of the valuable material manufactured by the plant. Since the amount of such material depends largely on conditions of soil and water-supply, which are outside our control, one line of development must be to increase the migration into the seed. This is especially urgent in drier countries where insufficient water-supply sets a definite limit to the amount of growth. With regard to the flour, considerable differences in milling operations have been brought about under the stress of war. The miller's object is to crack the wheat "berry" with the least possible breaking up of the husk, so that the endosperm falls out in a clean condition. The endosperm is the most digestible part of the grain and yields the best white flour. Before the war only about 68 per cent. of the weight of grain was recovered as white flour, while the remainder passed into various offals. During the war the extraction of flour from wheat rose to more than 90 per cent.; this brought into use certain valuable food elements which, however, are not suited to all constitutions.

Prior to the war only one-fifth of the wheat we consumed was home-grown; the rest came from North and South America, Russia, India, and Australia. Some of these supplies are now cut off, and although America has considerably increased her wheat acreage, the world's supply is still perilously short. For the next year the supplies are safe enough, but the permanent position is by no means assured. Unless more land is put under wheat a bad crop in one or two of the exporting countries would create a serious world shortage, so that as a national insurance we must grow more wheat. We can extend our acreage, and we can increase our production on the existing wheat-land, but in both cases better skill and more knowledge are required. The country, then, must be ready to encourage the attainment of knowledge, for "on knowledge hangs our assurance of a progressive food-supply in the future."

The Origin of Primary Ore Deposits.[1]

THE author commences at the period when the outer silicate shell of the earth was molten. The primeval magma is regarded as having been practically homogeneous and containing about 60 per cent. of combined silicates. All water was then in the atmosphere, giving a pressure more than 300 times as great as at present. As temperature fell, water and oxygen were absorbed; crust-formation, foundering, and resorption went on for a long period, producing a flat temperature gradient in the liquid. Viscosity eventually rendered further foundering impossible; the crust became permanent, granite developed, and below it the segregated basaltic magma long remained liquid. At this stage the isostatic balance was adjusted. Ore-minerals in large quantity were given off at the surface of the granite; these were denuded and dispersed in sediments and solution. This, with later absorption by intruded basic magma, is assumed to have been instrumental in causing the present erratic distribution of primary ores. All so-called water in magmas is held to exist in combination as hydroxyl with silica not in solution as a gas.

Magmatic differentiation is regarded as having been caused by the agency of silicic acid—silicon combined with hydroxyl—which extracts potash alumino-silicate producing a solution lighter than, and immiscible with, a melt of basic felspars and ferro-magnesian minerals. It is believed that in this way the first great split of primary magma into the world-wide granitic and basaltic types was brought about. Evidence regarding the existence of silicic acid in magmatic liquids and elsewhere in Nature is adduced. The ultimate result of the action of water on rock magmas is that silicates are completely removed and a residue of ore-minerals such as magnetite, ilmenite, and chromite left.

Vein-fissuring was brought about in and above batholiths by the expansive force due to the increase in solid specific volume of various elements. This increase is very considerable, exceeding in amount the contraction on solidification of the granite, and continues throughout the whole of the crystallisation period. The effect of this force appears in waves as fissures in successive series. These developed very rapidly, were instantly filled with magmatic mother-liquor, and were quickly sealed by the deposit of solids therefrom.

Quartz is almost always present in veins along with ore-minerals, and silica often occurs in solution in thermal springs, especially such as carry gold, arsenic, antimony, and mercury. For these and other reasons it is regarded as probable that primary ore-minerals passing up from magmas to veins do so in silicic acid solution, and possibly in combination. The deposition of these ores is usually caused by loss of heat and reduction of pressure. It is believed that there are definite, but narrow, limits of temperature between which each ore-mineral develops. These correspond to the temperatures in the strata at the bottom and the top of the ore at the time of deposition. Ore persisting for a vertical depth of 2000 ft. would, therefore, indicate normally a temperature range of 20° C.

The pneumatolytic theory of the origin of the high-temperature ores is rejected because the phenomena of their occurrence are quite inconsistent with what would result if these metals had been given off as gases by magmas. The boiling points of tungsten fluoride (19° C.) and tin fluoride (705° C.) are so far apart that it would be impossible for wolfram and cassiterite to have developed in contact with one another, as they frequently do. Accessory minerals such as fluorite and tourmaline lose the genetic significance usually attached to them owing to the fact that they are not invariably present with tin and tungsten ores, and are frequently associated with a variety of other ores which are admittedly of hydrothermal origin.

In introducing the paper the author directed attention to the probable importance of variations of pressure in ore solution and deposition. Separation from simple solution would involve deposition of ore along the whole upward course of the solvent. This does not take place, the end being usually abrupt in an upward direction. The phenomena in Nature seem to indicate that reduced pressure causes dissociation and, at some point, the total removal of ore from solution. High temperatures and pressures are not entirely correlative, and, since they usually accompany one another in Nature, it is possible that as regards ore-deposition we may in the past have been confusing the two.

[1] Abstract of a paper by J. Morrow Campbell read before the Institution of Mining and Metallurgy on October 21, 1920.

University and Educational Intelligence.

BIRMINGHAM.—The Tebbutt lectures on administration will be given during the coming term as follows: "The Central Departments of Government and their Relation to Local Administration," by Prof. W. G. S. Adams; "Municipal Administration," by Mr. Arthur Collins (treasurer of the City of Birmingham); "Educational Administration," by Sir Graham Balfour; and "Business Administration," by Mr. Gilbert C. Vyle (managing director of Avery's, Ltd.). The lectures will be open to the public.

SIR WILLIAM BRUNYATE has been appointed Vice-Chancellor of the University of Hong Kong in succession to Sir Charles Eliot.

IT is stated in *Science* of December 3 that an anonymous gift of 200,000 dollars has been made to the fund which is being raised by the American Engineering Foundation for the promotion of research in science and engineering.

A COURSE of ten lectures will be given at the Horniman Museum by Mr. F. Balfour-Browne on "Insects in Relation to Agriculture and Disease," beginning on Saturday, January 15. The course is primarily for teachers, but other persons will be admitted so far as accommodation permits; admission will be by ticket, which can be obtained from the curator at the museum. There will also be a series of ten free lectures on Saturday afternoons, starting on January 15, which will be of a simple, popular nature; two lectures each will be given by Mr. F. Balfour-Browne, Mr. E. Lovett, Dr. W. A. Cunnington, and Miss M. A. Murray, and two further lectures by Mr. H. N. Milligan and Mr. A. R. Wright.

AN election to a research studentship will take place at Trinity College, Cambridge, during July next and in each following year. The studentship will be open to graduates of universities other than Cambridge or to men who can show evidence of exceptional qualifications for research who are not members of the University of Cambridge. A candidate must obtain permission from the Board of Research Studies to enter the University as a research student, and will be expected to proceed to the new research degree of Ph.D. which has been established. The value of the studentship will vary according to the student's pecuniary circumstances, but will not exceed 200*l*. per annum, and the studentship will be tenable until the student is of standing to proceed to the degree of Ph.D. Applications should reach the Senior Tutor, Trinity College, Cambridge, not later than July 25.

THE British Lampblown Scientific Glassware Manufacturers' Association, Ltd., has arranged a series of lectures on glass in connection with the lampblown glass industry. Prof. W. E. S. Turner will deal with the manufacture and the properties of glass tubing and rods (three lectures); Mr. English will deliver three lectures on the manipulation of glass and the graduation of apparatus; Mr. Higgins will give three on thermometry and thermometer testing; Mr. Stott will deal with volumetric glassware (two lectures); and Mr. Davis will give the concluding lecture on technical points in the manufacture of bench-blown chemical glassware. The lectures will be delivered at the Northampton Polytechnic Institute, one every week; they commenced on Wednesday, January 5. Members of the association can attend the course free; others will be charged 2*s*. 6*d*. per lecture, or 10*s*. 6*d*. for the whole course. Further information can be obtained from Mr. W. H. Ashfield, British Lampblown Scientific Glassware Manufacturers' Association, Ltd., 2–3 Duke Street, St. James, S.W.1.

SOME interesting figures showing the salaries during 1920 of university and college officials in the United States are published in Bulletin No. 20 (1920) of the Bureau of Education. Data from 401 institutions have been collected, and, so far as possible, only salaries which recompense full-time service are given. Names are omitted, but the institutions dealt with are numbered and grouped in geographical divisions. In the detailed statements the president's salary is given, and succeeding columns show the number and salaries of the various deans, professors, associate and assistant professors, instructors, and assistants who are employed by the various institutions. Summaries are also provided of the various salaries which are allotted to the different posts, and these again are drawn together in two tables which show the maximum, minimum, average, and most frequent salaries attached to different offices in public and private institutions. The average salary for every post is higher in the former than in the latter type of establishment, due in part, no doubt, to the large number of small schools included in this class.

AFTER a break corresponding to two academic years, statistics are again available showing the number of doctorates in science which have been conferred in American universities (*Science*, November 19). In the year 1919–20, 328 such degrees were conferred by 31 institutions, as compared with 332 doctorates of 28 institutions for the year 1915–16, showing that normal conditions have been practically regained. As in previous years, the Eastern universities have conferred the greater number of degrees; Chicago University continues to head the list with 59, and this year Cornell University follows with 35 doctorates. Interesting figures are also given which show the distribution of the degrees among the various departments of science schools for the years 1912–16 and 1919–20. Chemistry continues to claim the greatest number; last year 96 doctorates were conferred in that subject—a total which is 19 short of the number given in 1916. Comparing the numbers for degrees in other sciences for the same two years, it is noteworthy that those conferred for physics and mathematics have decreased by 14 and 15 respectively, while the numbers for botany, zoology, and psychology have increased, the latter from 19 to 40. The increase is interesting because from the numbers given in previous years attention to that subject appeared to be declining steadily. No doctorates were conferred specifically for palæontology, mineralogy, metallurgy, or meteorology. The article concludes with the first instalment of a list giving the names of the recipients of the doctorates during 1919–20, together with the titles of their theses.

THE second term at University College, London, begins on Tuesday, January 11. During the term a number of public and other courses of lectures will be given, full particulars of which can be obtained from the Secretary, University College, London, W.C.1. The attention of readers of NATURE may be directed to the following:—Public Lectures: "The Navigation of Aircraft by Astronomical Observations," by Prof. L. N. G. Filon, on Friday, January 14; "Greek Medicine," by Dr. Charles Singer, on Friday, January 28; "Basque Customs," by Prof. J. E. G. de Montmorency, on Thursday, February 24; "The History of Plant Delineation," by Dr. Charles Singer and Dr. Agnes Arber, a course of four weekly lectures commencing on March 2; and "The British Museum in War-time," by Sir Frederic Kenyon, on Friday, March 4. The following courses of lectures will also commence on the dates indicated:—"Fine Art Anatomy," by Prof. G. Elliot Smith, on Monday, January 10; "History of Mathematics up to the Eighteenth Century," by Mr. T. L. Wren, on Tuesday, January 11; "General History and Development of Science," by Dr. A. Wolf (continued from 1st term), on Wednesday, January 12; "Measurements of Stresses in Materials and Structures," by Prof. E. G. Coker, on Monday, January 17; "Mathematical Theory of Relativity," by Dr. G. B. Jeffery (continued from 1st term), on Monday, January 17; "History of the Biological and Medical Sciences from Early Times to the Eighteenth Century," by Dr. Charles Singer (continued from 1st term), on Tuesday, January 18; "The Present State of our Knowledge of the Science of National Eugenics," by Prof. Karl Pearson, on Wednesday, January 10; "Spectroscopy, General and Applied," by Dr. S. Judd Lewis, on Friday, January 21; and "Development of Medicine in Modern Times," by Dr. Charles Singer, on Tuesday, March 8.

Calendar of Scientific Pioneers.

January 7, 1786. Jean Etienne Guettard died.—The discoverer in 1752 of the extinct volcanoes of Auvergne and the compiler with Lavoisier of a mineralogical map of France, Guettard has been called "the father of all the national Geological Surveys."

January 7, 1893. Joseph Stefan died.—Professor of physics at Vienna and director of the Physical Institute, the law of cooling which bears Stefan's name was enunciated by him in 1879.

January 8, 1642. Galileo Galilei died.—The founder of the science of dynamics and one of the greatest of the early experimentalists, Galileo, wrote J. D. Forbes, "was beyond all comparison the glory of his age." Some years older than Kepler, Galileo was born in 1571 at Pisa, where he studied and lectured and made his experiments on falling bodies. The leaning Tower of Pisa now bears the inscription:

GALILEUS GALILEJUS
Experimentis E Summa Hac Turri Super Gravium
Corporum
Lapsu Institutis
Legibus Motis Detectis
Mechanicen Condidit
Ingentibusque Suis Posteriorumque Sophorum Inventis
Praelusit

The astronomical discoveries of Galileo were made while he held the chair of mathematics at Padua. In 1609 he heard of the invention of a crude telescope. Seizing upon the idea, he made an instrument to magnify thirty times, and within eighteen months he had observed the mountains and craters of the moon, seen the planets as discs, counted forty stars in the Pleiades, discovered four of the satellites of Jupiter, was perplexed by the curious appearance of Saturn due to the ring-system, observed the gibbous, as well as the crescent, phase of Venus, and had closely followed the spots in the sun. He was then at the zenith of his career. The greater part of his later life was passed at Florence, and to this period belong the controversies and persecutions which embittered his last days.

January 9, 1848. Caroline Lucretia Herschel died.—Returning to England with her brother William in 1772, Caroline Herschel for fifty years was his most patient, skilful, and zealous assistant. The minor planet Lucretia was named after her by Palisa in 1889.

January 10, 1778. Linnæus died.—Carl von Linné or Linnæus was born on May 3, 1707, at Roëshult, Sweden. A student at Lund and a lecturer at Upsala, through much poverty he clung to his first love of botany. An expedition to Lapland was followed by travels in Holland, England, and France. In 1741 he became professor of anatomy and physics in the University of Upsala, but the following year was appointed to the chair of botany. His last edition of his "Systema Naturæ" appeared in 1768.

January 10, 1833. Adrien Marie Legendre died.—The contemporary of Laplace and Lagrange, and the instructor of Cauchy and Arago, Legendre was on the Commission for connecting Greenwich and Paris by triangulation, and made notable additions to various branches of higher mathematics.

January 12, 1665. Pierre de Fermat died. Born in the province of Gascony, Fermat was trained as a lawyer, and became a councillor of the local Parliament at Toulouse. He was the correspondent of Descartes, Torricelli, Pascal, Huygens, Wallis, and others, and made additions to geometry, the calculus of probabilities, and the theory of numbers.

E. C. S.

Societies and Academies.

LONDON.

Faraday Society, December 13.—Sir Robert Hadfield, Bart., president, in the chair.—Prof. E. D. **Campbell**: A force field dissociation theory of solution applied to some properties of steel. Understanding of the properties of alloys has been obscured by the use of the term "solid solution" and by expressing constitution in terms of percentage weights. There is no essential difference between a liquid and a solid solution, and the constitution of both should be expressed as molecular or atomic concentrations per unit volume. The electrolytic dissociation theory in its usual form is inapplicable to alloys. The force field theory is a modified form of it applicable to liquid and solid solutions alike. The assumption is made that in a molecule the electromagnetic force field associated with the constituent atoms is closed in the combination, but in solution this force field is opened out by the solvent to an extent depending on concentration and composition. The reactivity of ions is due to the open force fields, and not to the presence of electric charges. In the presence of an impressed e.m.f. the resultant of the reactivity is electrical resistance in the case of metallic solutions, and electrical conductance in aqueous solutions.—A. L. **Norbury**: The electrical resistivity of dilute metallic solutions. It is well known that the small quantities of impurities in solid solution cause a large increase in the electrical resistivity of a pure metal. Data are collected showing the relative atomic effects of such impurities, and a certain relationship appears to be brought out by doing so. The author summarises his conclusions as follows:—(1) A comparison with the atomic volumes, intrinsic pressures, electrical resistivities, thermo-electric properties, and decomposition potentials of the elements concerned shows that none of these atomic properties can be directly applied to explain the results. It is suggested that the atomic effects are small when there is little electrical attraction between the atoms of solute and solvent, and large according as the electrical attraction between the two is greater. (2) It seems probable that in the dilute solutions quoted the atoms of solute are not associated. (3) Assuming, for example, the face-centred cube lattice in a dilute solid solution, an atom of solute will be surrounded by twelve equidistant atoms of solvent, and will not be attached to any one of these atoms in particular. It will, therefore, exert attractive forces on the electrons of the surrounding atoms. (4) It is generally assumed that metals conduct the electric current by means of their "free" electrons; the presence, therefore, of forces restraining the "free" electrons in solid solutions will account for their diminished conductivity.

Geological Society, December 15.—Mr. R. D. Oldham, president, in the chair.—Dr. T. O. **Bosworth**: Structure and stratigraphy of the Tertiary deposits in north-western Peru. The westernmost ranges of the Andes in the north of Peru are of pre-Tertiary age. The Tertiary rocks occupy a narrow strip of country between the mountains and the sea, and they consist of 15,000 ft. to 25,000 ft. of clay-shales and sandstones, with thin seams of beach-pebbles and shells. During the Tertiary period a large subsidence was in progress. The stratigraphical succession is:

		Ft.
MIOCENE.	Zorritos Formation	5000+
EOCENE.	Lobitos Formation	5000+
	Negritos Formation.	
	(Clavilithes Series) (Turritella Series)	7000+

The Tertiary accumulation is greatly broken up by intense block-faulting; between the fault-blocks are differential displacements of many thousands of feet. An important movement probably occurred along a great fault-belt parallel with the Andes.—H. **Woods**, Dr. T. W. **Vaughan**, Dr. J. A. **Cushman**, and Prof. H. L. **Hawkins**: Palæontology of the Tertiary deposits in north-western Peru. The fauna of the Negritos formation is of shallow-water gastropods and lamellibranchs, with a small number of teeth of fishes, decapod crustacea, corals, and one Echinoid. Aturia is also present. The number of species is large, and nearly all are new. By the stages reached in the evolution of Venericardia of the Planicosta group correlation is made with the Tejon group of California; but the relation to the Wilcox and Lower Claiborne groups of the Eastern and Gulf States of America is more marked, and is sufficient to indicate the existence of a sea-connection between the Pacific and the Atlantic. The Lobitos formation is distinguished by Foraminifera of the genera Lepidocyclina and Orthophragmina. In the Zorritos formation Miocene age is indicated by the similarity of some of the gastropods and lamellibranchs to those of the Miocene of Panama.—Dr. T. O. **Bosworth**: Geology of the Quaternary period on a part of the Pacific coast of Peru. Throughout the Quaternary period the littoral has undergone a series of vertical oscillations having a hinge-line in the Andes. The ocean-soundings show a steep 2000-ft. submarine cliff at the edge of the continental shelf. This cliff is taken to be a submarine fault-scarp, marking the important fracture (Pacific fault) which was the western boundary of the Quaternary uplifts. The oldest and highest of the raised sea-floors now has an elevation of 1100 ft. It extends 20 miles inland, and, within the territory discussed, covers an area of 700 square miles. The inland boundary of each "tablazo" is a raised sea-cliff. The original western limit of each one of them was probably the edge of the continental shelf. The depth, 27 miles from the present coast, is 12,000 ft. The Quaternary deposits formed upon it are presumably deep-sea oozes. The events on the east side of the Pacific fault are grouped into four similar episodes. Each consists of a subsidence accompanied by marine transgression, followed by an uplift causing emergence of new land. They are: (1) The Mancora, (2) the Talara, (3) the Lobitos, and (4) the Salina episode. Four episodes have left their mark. The most substantial of the deposits formed during these marine transgressions is 250 ft. thick. The material ranges from shell-limestone to beach-pebbles. The shells have been examined by Col. A. J. Peile, who pronounces them (probably all) to be living species. On the land extensive breccia-fans and valley-terraces were produced under desert conditions during these oscillations. It is considered that not one ten-thousandth part of the Quaternary history outlined can have taken place within the last five hundred years.

PARIS.

Academy of Sciences, December 13.—M. Henri Deslandres in the chair.—C. **Guichard**: Networks which comprise a family of geodesics, and such that their reciprocal polar with respect to a linear complex is a network O.—H. **Parenty**: The waves of shock of A. Dévé.—P. **Vuillemin**: The inflorescence of *Fuchsia coccinea*.—A. **Buhl**: Double integrals in which the pseudo-lines at infinity are zero lines.—T. **Varopoulos**: A class of functions with an infinite number of branches.—M. **Takagi**: Bodies resolvable algebraically.—M. **La Porte**: The utilisation of tidal currents on the coasts of France. Instead of holding back the water by a dam, involving costly constructive work, it is proposed to make use of the horizontal current to move a wheel or turbine. A list of suitable channels on the French coast is given, with details of the current velocities.—A. **Danjon**: New determination of the solar period based on the law of luminosity of the eclipses of the moon. By this method the solar period is found to be 10·87 years between 1583 and 1912.—Z. **Klemensiewicz**: Contribution to the theory of thermal radiation.—S. **Posternak**: The hexabasic polymolybdates.—L. **Moret**: The lithological constitution of the Nummulitic and the Upper Cretacean of the Arâche plateau (Platé massif, Haute-Savoie).—L. **Cayeux**: The cause of the high phosphorus content of the Lorraine minerals. Reasons are given for supposing that the high phosphorus content of the Lorraine iron-ore is of organic origin; remains of fishes are exceptionally abundant.—C. **Gorceix**: Traces of man in the Voglans lignites (Savoie). The fall of a roof in the lignite mine exposed a layer of wood-charcoal, considered by the author as caused by human agency.—P. **Glangeaud**: The traces left in the central French massif by the glacial invasions of the Pliocene and Quaternary: the extent and multiplicity of these invasions. To the parts of the central massif on which glacial action has been proved must now be added the mountains Margeride (at the head of the valleys of the Allier and the Truyère) and Lozère, a part of the Hautes Cévennes, and the Velay. Altogether, more than an eighth of the central massif must have disappeared under ice, snow, or névé. The factors which have contributed to the attenuation or effacement of traces of glacial action in this region are discussed.—Mlle. Y. Boisse **de Black** and P. **Marty**: The origin of certain *claux* of Cantal.—C. E. **Brazier**: The measurement of the vertical component of the velocity of the wind with the aid of anemometric vanes. The instrument known as the clino-anemometer has led to the paradoxical conclusion that the air, instead of flowing horizontally, has an average movement at all seasons of the year of a vertical velocity of about 0·5 metre per second. An experimental study of this instrument in the laboratory has shown that the velocity of rotation, instead of being, as previously assumed, proportional to the vertical component of the wind velocity, is proportional to a fraction of this component, which is smaller as the inclination of the wind to the horizon is reduced. The meaning of the older observations is discussed in the light of these new facts.—A. **Piédallu**, P. **Malvezin**, and L. **Grandchamp**: The action of oxygen on the musts of red grapes. The oxygen in these experiments was passed into the liquid in very minute bubbles through the walls of a porous cell. Practically the whole of the red colouring matter was removed by this treatment.—R. **Wurmser** and Mme. J. **Duclaux**: Photosynthesis in the algæ *Chondrus crispus* and *Rhodymenia palmata*.—P. **de Beauchamp**: Biogeographical researches on the zone of tides at the Island of Ré.—M. **Doyon**: The mechanism of the action of morphine on the coagulability of the blood. The effect is not produced *in vitro*. The property of incoagulability is due to the presence of a nucleoprotein secreted by the organism under the action of morphine, and the circulating blood is capable of preventing, *in vitro*, the coagulation of the blood of a normal subject.—S. **Tchahotine**: The method of microscopic radio-puncture: a means of analysis in experimental cytology. The production of a mechanical lesion of a single cell offers great experimental difficulties. In place of this the author acts on the cell with an extremely thin bundle of ultra-violet rays of a diameter not greater than 5μ. Details of the technique are given.—A. **Salimbeni**: The nature of the bacteriophage of d'Herelle.—P. **Séguin**: Culture of the buccal spirochæta favoured by some bacteria.

ROME.

Reale Accademia dei Lincei.—(Communications received during the vacation.)—F. **Bottazzi**: Striated muscles and ligaments of homœothermic animals, xiii. Contraction of striated muscle by cold.—G. **Fano**: Surfaces of the 4th order with infinite discontinuous birational transformation groups, iii.—G. **Fubini**: Contravariant differentials.—M. T. **Ambrosetti**: Projective determination of a congruence W.—U. **Bordoni**: Isentropic transformations of univariant systems.—L. **Stipa**: Projectively applicable surfaces.—A. **Terracini**: Spaces tangential to a given variety, i.—F. **Tricomi**: Expansion of integrals of a differential equation in a series of definite integrals.—W. **Del Regno**: Variations of electric resistance in nickel-steel due to heat, i.—G. **Canneri**: Nitrite of thallium.—R. **Ciusa**: Salts with *o*-, *m*-, and *p*-quinoid structures, ii.—C. **Mazzetti**: Double ternary systems with lacuna of miscibility in liquid and solid states, i.—G. **Rovereto**: Erosive action in continuous, as opposed to cyclic, development.—E. **Carano**: Cyto-embryonic studies in Erigeron.—L. **Beccari**: Action of adrenalin on the heart.—D. **Maestrini**: Studies of enzymes, iv. Emulsin, cytasis, ereptasis, and ureasis of germinating barley.—M. **Boldrini**: Sexual differences in weight of human body and organs, iii.—E. **Federici**: Campaign against Anopheles larvæ by means of aquatic insects, i.—G. **Fano**: Surfaces of the 4th order with birational transformation groups, iv.—G. **Armellini**: Observations on secular comets. The author disagrees with the prevailing opinion that parabolic orbits are necessarily of stellar origin.—A. **Terracini**: Spaces tangential to a given variety, ii.—W. **Del Regno**: Variations of electric resistance in nickel-steel, ii.—C. **Mazzetti**: Double ternary systems, ii.—M. **Padoa**: Specific heats.—P. **Comucci**: Metamorphoses of contact between limestone and granitic porphide in metalliferous deposits of Oroli, in Sardinia.—S. **Sergi**: Intercostal muscles and sexual differences in respiration of the chimpanzee.—G. **Quagliariello**: Proteid and residual nitrogen in serum of blood of vertebrates and invertebrates.—E. **Federici**: Campaign against Anopheles larvæ by aquatic insects, ii. This part deals with the predaceous Coleoptera and Rhynchota. Of these the beetles and water-scorpions appear rarely to select Anopheles larvæ as their prey; on the other hand, water-boatmen are the most voracious destroyers of the mosquito larvæ, and water-measurers also frequently attack them.—L. **Bianchi**: Quadratic character of numbers in a quadratic body.—G. **Fano**: Surfaces of the 4th order with infinite groups, v.—C. **de Stefani**: Siliceous fossil sponges of western Liguria, ii. These sponge remains occur in the Lower Trias at Arenzano in quartzite, in the Middle Trias of Voltaggio, in the Triassic limestone of Spotorno, and in a peculiar Triassic formation at Isoverde.—G. **Armellini**: Determination of latitude of the Capitoline Observatory, i.—E. **Federici**: Campaign against Anopheles larvæ by aquatic insects, iii. After considering the orders Neuroptera and Pseudoneuroptera the author, in summarising, concludes that the method is of very limited efficacy.—M. **Cantone**: Elastic molecular forces and resulting vibrations.—R. **Serini**: Theory of the circular-plate electric condenser, ii.—G. **Armellini**: Latitude of the Capitoline Observatory, ii. The mean values of three series of observations in 1920, viz. 41° 53′ 33·05″, 33·17″, and 33·28″, show the variation of latitude due to shifting of the earth's axis.—U. **Crudeli**: Oscillatory progressive waves of permanent type, second approximation.—I. **Galotti**: "Glandular coupling" in larval stomach of *Rana esculenta*. The organ described under this name by Ruffini in 1899 occurs in the larva of the frog, and was regarded as going to form part of the glandular system of the stomach of the definitive form.—S. **Pastore**: Action of saliva on starch in presence of gastric and pancreatic juices.—O. **Munerati**: Influence of low temperature on germination of freshly gathered corn and other seeds. In confirmation of a result previously found by G. T. Harrington, these experiments showed that at temperatures of about 12° C. more than 90 per cent. of the fresh corn and seeds germinated in a few days, whereas at higher temperatures very few began to grow.—M. **Ascoli** and G. **Izar**: Action of serum of pregnancy on placenta extracts.

Books Received.

Ministry of Finance, Egypt. Survey of Egypt. Meteorological Report for the Year 1914. Pp. xii+242. (Cairo: Government Press.) P.T. 30.

The Place-Names of Northumberland and Durham. By Prof. A. Mawer. Pp. xxxviii+271. (Cambridge: At the University Press.) 20*s*. net.

The British Journal Photographic Almanac and Photographer's Daily Companion, 1921. Pp. 840. (London: H. Greenwood and Co., Ltd.) 2*s*. net.

Scientific Life and Works of H. C. Ørsted. Edited by K. Meyer. (From H. C. Ørsted; Scientific Papers, vol. i.) Pp. clxvi. (Copenhagen: A. F. Høst and Son.)

La Faculté de Médecine de l'Université de Paris. Pp. 84. (Paris: Masson et Cie.) 1 franc.

Technique des Pétroles. By R. Courau. Pp. 406+19 plates. (Paris: O. Doin.) 16 francs.

Elements of Statistics. By Prof. A. L. Bowley. Fourth edition. Pp. xi+459. (London: P. S. King and Son, Ltd.; New York: C. Scribner's Sons.) 24*s*. net.

The Scientists' Reference Book and Diary, 1921. (Manchester: J. Woolley, Sons and Co., Ltd.) 3*s*. 6*d*.

Nedbøriagttagelser i Norge utgit av det Norske Meteorologiske Institut. Aargang XXV., 1919. Pp. xii+80+45. (Kristiania: H. Aschehoug and Co.) 6 kroner.

Jahrbuch des Norwegischen Meteorologischen Instituts für 1919. Pp. xii+173. (Kristiania.)

The Basis of Psychiatry (Psychobiological Medicine). By Dr. A. C. Buckley. Pp. xii+447. (Philadelphia and London: J. B. Lippincott Co.) 30*s*. net.

Autobiography of Andrew Carnegie. Pp. xii+385. (London: Constable and Co., Ltd.) 25*s*. net.

Abnormal Psychology and its Educational Applications. By F. Watts. (Published in its first edition as "Echo Personalities.") Pp. 191. (London: G. Allen and Unwin, Ltd.) 7*s*. 6*d*. net.

Psychology and Psychotherapy. By Dr. W. Brown. Pp. xi+96. (London: E. Arnold.) 8*s*. 6*d*. net.

Macmillan's Historical Atlas of Modern Europe. Edited by Prof. F. J. C. Hearnshaw. Pp. ix+30+xi maps. (London: Macmillan and Co., Ltd.) 6*s*. net.

The Mathematical Theory of Electricity and Magnetism. By Prof. J. H. Jeans. Fourth edition. (Cambridge: At the University Press.) 24*s*. net.

Studies in Minor Folds. By C. E. Decker. Pp. ix+89+3 plates. (Chicago: University of Chicago Press; London: Cambridge University Press.) 1.50 dollars.

L'Idéal Scientifique des Mathématiciens dans l'Antiquité et dans les Temps Modernes. By Prof. P. Boutroux. Pp. 274. (Paris: F. Alcan.) 8 francs net.

The Trees, Shrubs, and Plants of Virgil. By J. Sargeaunt. Pp. vii+149. (Oxford: B. H. Blackwell.) 6*s*. net.

Tenth Report of the Development Commissioners for the Year ended 31st March, 1920. Pp. vii+242. (London: H.M. Stationery Office.) 2s. net.

Meteorological Office. Air Ministry. British Rainfall, 1919. The Fifty-ninth Annual Volume of the British Rainfall Organization. Pp. xxviii+268. (London: H.M. Stationery Office.) 12s. 6d. net.

L'Alimentation et l'Elevage Rationnels du Bétail. (Opinions du Prof. A. Mallèvre.) By J.-E. Lucas. Pp. 466+4. (Paris: Librairie Lefrançois.) 18 francs.

The University of Chicago. Publications of the Yerkes Observatory. Vol. iv., part iii. Parallaxes of Fifty-two Stars. By G. van Biesbroeck and Mrs. H. S. Pettit. Pp. 36. (Chicago: University of Chicago Press; London: Cambridge University Press.) 1.50 dollars net.

Hydro-Electric Survey of India. Vol. ii. Second Report on the Water Power Resources of India. Ascertained during the Season 1919–20. By F. E. Bull and J. W. Meares. Pp. 123. (Calcutta: Government Printing Office.) 1.6 rupees.

Analysa Kvalitativní pro Posluchače (Začátečníky) České University. (Qualitative Analysis for Students (Beginners) of the Bohemian University.) By Prof. Dr. B. Brauner and Dr. J. Křepelka. Pp. 179. (Prague: Československé Lékánické Společnosti.)

Geologists' Association, London. An Index to the Proceedings of the Geologists' Association, vols. xxi.–xxx., 1909–19. Pp. 44. (London: E. Stanford, Ltd.) 5s.

Design and Tradition: A Short Account of the Principles and Historic Development of Architecture and the Applied Arts. By A. Fenn. Pp. xx+376+plates. (London: Chapman and Hall, Ltd.) 30s. net.

The Growth and Shedding of the Antler of the Deer: The Histological Phenomena and their Relation to the Growth of Bone. By W. Macewen. Pp. xvii+109. (Glasgow: Maclehose, Jackson and Co.; London: Macmillan and Co., Ltd.) 10s. 6d. net.

The Principle of Relativity. Original Papers by A. Einstein and H. Minkowski. Translated into English by M. N. Saha and S. N. Bose. Pp. xxiii+186. (Calcutta: University.)

Diary of Societies.

THURSDAY, JANUARY 6.

ROYAL SOCIETY OF ARTS, at 3.—Sir Frederick Bridge: The Cries of London which Children heard in Shakespeare's Time (Juvenile Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. J. Arthur Thomson: The Haunts of Life: The Freshwaters (Juvenile Lectures).

PHYSICAL SOCIETY AND OPTICAL SOCIETY'S EXHIBITION (at Imperial College of Science), from 3 to 10.—At 4.—Prof. A. Barr: The Optophone.—At 8.—C. R. Darling: Some Unusual Surface Tension Phenomena.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—Dr. Louise McIlroy: The Use of Morphia in Labour.—P. Cole: A Series of 43 Cases of Inoperable Uterine Carcinoma treated by the Cold Cautery Method of Percy.

FRIDAY, JANUARY 7.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.30.—Lt.-Col. C. Smith: Life on the Gilgit Frontier (Christmas Lecture).

JUNIOR INSTITUTION OF ENGINEERS (at Caxton Hall), at 8.—H. G. Pusey: The Indicator: Its Use and Application.

SATURDAY, JANUARY 8.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. J. Arthur Thomson: The Haunts of Life: The Conquest of the Land (Juvenile Lectures).

MONDAY, JANUARY 10.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Meeting), at 7.—A. H. Fuller: The Artificial Production of Ice.

SURVEYORS' INSTITUTION, at 8.—W. W. Jenkinson: The Streets of London before the Great Fire.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Capt. J. B. L. Noel: A Reconnaissance in Persia North of the Elburz.

TUESDAY, JANUARY 11.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. J. Arthur Thomson: The Haunts of Life: The Mastery of the Air (Juvenile Lectures).

ROYAL HORTICULTURAL SOCIETY, at 3.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.

INSTITUTE OF INDUSTRIAL ADMINISTRATION (in Central Hall, Westminster), at 7.—W. J. Malden: The Measure of Output in Agriculture.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. Rheinberg: Some New Directions for Photographic Research.—F. C. Toy: A Monochromatic Illuminator of Special Design.

QUEKETT MICROSCOPICAL CLUB (at 11 Chandos Street, W.1), at 7.30.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Prof. C. G. Seligman: The Older Palæolithic Age in Egypt.

ROYAL SOCIETY OF MEDICINE (Psychiatry Section), at 8.30.—Dr. Morowoka: The Morbid Conditions of the Choroid Plexus in Mental Disease (Illustrated by Epidiascope).

WEDNESDAY, JANUARY 12.

ROYAL SOCIETY OF ARTS, at 8.—Dr. C. S. Myers: Industrial Fatigue (Aldred Lecture).

INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.—Capt. S. Bramley-Moore: Recent Developments in Transmission.

THURSDAY, JANUARY 13

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—A. C. Dixon: The Theory of a Thin Elastic Plate, Bounded by Two Circular Arcs and Clamped.—A. S. Eddington: Dr. Sheppard's Method of Reduction of Error by Linear Compounding.—M. Kössler: The Zeros of Analytic Functions.—G. A. Miller: Determination of all the Characteristic Sub-groups of an Abelian Group.—E. A. Milne: A Problem concerning the Maxima of Certain Types of Sums and Integrals.—H. J. Priestley: The Linear Differential Equation of the Second Order.—W. F. Sheppard: Conjugate Sets of Quantities.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Sir William Bragg: Electrons (Kelvin Lecture).

OPTICAL SOCIETY (at Imperial College of Science), at 7.45.—Prof. W. Salomonson: A New Ophthalmoscope.—H. Dennis Taylor: An Anastigmatic Flat Field Telescope and its Application to Prismatic Binoculars.—Inst.-Comdr. T. Y. Baker: A Note on Multiple Reflection.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Informal Meeting for Free Discussion.

FRIDAY, JANUARY 14.

ROYAL ASTRONOMICAL SOCIETY, at 5.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—Dr. R. Pickard: Variations in the Size of the Physiological Cup, and their Relation to Glaucoma.—B. T. Lang: Scotometry.

CONTENTS.

NATURE

THURSDAY, JANUARY 13, 1921.

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The Development of Agriculture.

THE latest annual report of the Development Commissioners[1] takes the form of a review of the work of the Commission since its establishment in 1909. It includes another novel feature in a series of reports on the past work and future outlook of the research institutes supported by the Commission. These reports have been prepared by the directors of the laboratories, and, covering, as they do, a large part of the field of biology, would, if space permitted, repay detailed consideration. They bear witness to a considerable output of original work, not only in applied science, but also in fundamental research. Of the progress made in the latter, the report on the Rothamsted Experimental Station contains the most noteworthy examples. In 1909 the scientific staff there numbered five only; the technical staff now numbers nearly seventy, of whom twenty-five are university graduates, and the annual grant made by the Commission (through the Ministry of Agriculture) has nearly quintupled the original income of the station. The output and quality of original work at this station in the last decade are well known to our readers. As an example of successful technological investigations, the Fruit Experiment Station established at East Malling, in Kent, may be instanced. The success achieved by this station in improving the value of orchard trees is an example of the rapidity with which the application of science to industrial problems can achieve results of economic importance. As the Commissioners point out, owing largely to the lack of trained workers, the advance of knowledge in relation to the problems of agriculture after the great achievements of Lawes and Gilbert *circa* 1860 was inconsiderable. In a large degree this sterility was caused by the need of money—a need which the Development Fund has supplied. In these circumstances it was not surprising that agricultural education, too, was in danger of becoming outworn. Research and education are closely correlated; each is dependent on the stimulation provided by the other.

The scheme of the Development Act was novel in so far as it provided a fund for the economic development of agriculture to be expended under the direction of a quasi-judicial body without executive powers, "not responsible to any Minister and to that extent insusceptible to political pressure." The Commissioners apparently wish to contrast the limitation of their powers with the freedom of other bodies concerned with the State support of research recently established. They also refer to the statutory restriction of their advances to non-profit-making concerns, and seem to suggest that this limitation in some degree diminishes their usefulness; it certainly appears to be a restriction which is not congruent with the subsequent policy of the State in relation to scientific research.

Measures have also been taken to promote research in the economic problems of our fisheries. A scheme has been developed which provides, *inter alia*, for a large measure of control by a committee of men of science and for the separate orientation of free (or fundamental) from "directed" (or technological) research. Free research will, very properly, be regarded as the function of universities and other independent bodies, while "directed" research—that directly concerned with economic developments—will be entrusted to the various State departments connected with fisheries. We commend the dichotomy to the consideration of the Commissioners in the other aspects of their activities.

The report is noticeably silent on one administrative aspect of all research schemes which is the subject of active controversy at the present time. In a recent issue we commented on the admirable scheme fostered by the Commission under which research workers in agriculture have

[1] Tenth Report of the Development Commissioners for the Year ended March 31, 1920. (H.M. Stationery Office.) Price 2s.

been guaranteed a quasi-permanent tenure and adequate salaries. A letter from Prof. Stanley Gardiner, which we publish elsewhere, shows that the Commissioners' attitude to this question in relation to fishery research has not been productive of satisfaction. Our correspondent's letter raises an issue of great importance. No State-aided scheme of research will be productive unless it attracts as well as retains men of the highest academic attainments.

In one chapter of the report the general economic position of agriculture at the present day is contrasted with that which followed the Napoleonic wars. The conclusion is drawn that agriculturists must be up and doing if disaster is to be averted. We hope that if the adequacy of future efforts as tillers of the soil is dependent on our reaching the standard of hard work attained by our ancestors in the period 1816 onwards, we shall be encouraged by what their successors achieved in other fields in the period 1914–18.

In conclusion, we may pay a tribute of respect to those who have formed the varying and co-operative *personnel* of the Commission and of the Ministry of Agriculture during the last ten years. There can be no doubt that as pioneers in the field of the deliberate encouragement of scientific research by the State they have fully justified the prescience of the founders of the Development Fund.

The Critic in Physiology.

Warfare in the Human Body: Essays on Method, Malignity, Repair, and Allied Subjects. By Morley Roberts. With an introduction by Prof. Arthur Keith. Pp. xiii+286. (London: Eveleigh Nash Co., Ltd., 1920.) Price 18*s*. net.

THE author of this book, although well known in the fields of literature and art, astonishes us by the amount and depth of his knowledge of the biological sciences. A great service is done by the subjection to criticism of current views, especially when the critic is one not actually engaged in the investigations on which they are based. Owing to the wide extent of his outlook, he is often able to throw light on questions which those who, by the exigencies of research, are compelled to an intensive study of a narrow field are apt to miss. We may not entirely agree with his criticisms, but they always make us consider what we really mean by the statements we make. It is not to be understood, however, that the book before us consists merely of criticism. There is much in it of constructive and helpful suggestion.

Although in form consisting of apparently separate essays on such problems as cancer, repair, inhibition, immunity, heredity, cannibalism, bathing, consciousness, and so on, there may be said to be a common thread running through them, and this thread is the belief that much assistance may be given in the comprehension of biological problems by bringing them into relation with analogous cases in the sociological sciences. In the first essay, "On Method in Science," a powerful defence is given of the use of analogy. The author is well aware of the caution necessary to avoid pitfalls. Thus a similar result is not always due to a similar cause, while the metaphorical use of words is no real advance. As an illustration the author refers to Adami's "habit of growth" acquired by cancer cells. Moreover, an analogy suggests different things to different people. As to the way in which it may be used with profit, the original must be read.

Owing to the variety of topics discussed, this review is almost of necessity somewhat disconnected. Furthermore, when the reviewer brings forward objections to certain statements, the impression is apt to be given that he is less in sympathy with the work as a whole than is actually the case. The proportion of statements not agreed with to the rest of the book, with which the reviewer is almost entirely in agreement, must be kept in mind.

A consideration suggested by the title needs a few words at this point, and illustrates a remark made above. Owing to the limitations of language, it is probable that the author's meaning has not been quite correctly grasped, and if this be so we may hope for more essays from his pen in order to make things clear. The word "warfare" will almost certainly not be understood by every reader in the same way. If offensive warfare is implied, it is doubtful whether a true impression is given of physiological processes. Indeed, even the conception of defensive warfare is liable to misinterpretation. If we may regard the components of a reversible chemical reaction as being at war with one another, we may let the name pass, and the remarks of the author on p. 30 seem to imply that this is the way in which he looks at the matter. But is it correct to speak of immunisation as "active warfare"? (p. 138). It cannot be denied that the acts of war "tend to develop all the logical and mental faculties of man" (p. 169), but it does not follow that this is the only way to do this, or the most effective way. It might, not unreasonably, be held that certain valuable qualities are not so developed.

When it is stated that the "unfit" are eliminated, we may ask, Unfit for what? Is not the statement on p. 161 that "union is never voluntary" rather too sweeping? Warfare in most minds is associated with the idea of destruction—that is, of waste. This is perhaps not an essential part of its meaning, and the reviewer is aware that his point of view may not be that of other readers of the book.

Turning to the second essay—that on "Malignancy"—we note that the author, after a profound discussion of various views, comes to the conclusion that it is due to the failure of the mutual action of connective-tissue and epithelium on one another, perhaps under the influence of some internal secretion. We may compare the view put forward by Dr. A. Paine in the *Lancet* of October 2, in which the noxious influence of certain irritants, especially of bacterial toxins, is held to be responsible for the degeneration of the specialised functions of the epithelial cell, so that it returns to its embryonic state. If Mr. Morley Roberts's conclusion is correct, we are led to regard much of the cancer research of the present day as beginning at the wrong end, so to speak. We must learn more about the normal dependence of one tissue on the activities of another before we proceed to examine what happens when this dependence is disordered. Too much direct attack is made on disease before an accurate knowledge of what health really is has been obtained. In this connection we may refer to the apt illustration by the author on p. 4, where it is pointed out that it would be absurd to think of learning how to build a ship by examination of wrecks on the shore.

These considerations may be commended to the attention of the Ministry of "Health." In fact, in the investigation of cancer, as in that of immunity, too narrow a point of view is often taken. The author rightly insists (p. 64) on the vital importance of taking account of work in branches of science other than that actually in view. It must often strike even the moderately cultured investigator how sadly lacking in knowledge of general principles so many of the workers in specialised subjects are apt to be. Many industrial "inventors" would save themselves much trouble, as well as loss of money, by learning more about the fundamental principles of science. This lack is perhaps particularly noticeable in those devoted to the subject of immunity, although there are, of course, notable exceptions, and much excuse must be made owing to the unfortunate domination of the Ehrlich phraseology, against which our author justly protests (pp. 127, etc.). As he points out, we cannot explain a bacteriologist by saying that he is bacteriological. One is sometimes inclined to wish that some gifted investigator who knows nothing of previous work on immunity would attack the problem at its foundations.

The third essay is of much interest. Dealing with the problem of repair, it propounds the thesis that the evolution of an organ is frequently a case of the mending of a breakdown. This opinion, although supported with much evidence, will probably evoke some dissent. But all readers will agree that there are gaps in our knowledge of the processes of repair and of hypertrophy resulting from functional activity. The author's views on direct adaptation are also difficult to accept in their entirety. Although the accessibility of the germ plasm to chemical agents, as in Stockard's experiments with the action of alcohol on guinea-pigs, cannot be denied, there is no reason to suppose that a modification would be of such a kind as to be appropriate in combating the change in the environment. One is somewhat surprised to find that the author accepts the statements of Abderhalden with respect to the production of "protective enzymes."

Turning to another interesting question—that of inhibition—it is curious that the author, although making use of the conception in the case of the nervous system, finds difficulties in the action of the vagus nerve on the heart. This may be due to the interpretation he puts on the word "depressant." Inhibition, whatever explanation we may try to give of the way in which it is brought about, means no more than stopping a process or reducing its intensity, no harm being done to the active cells. Neither is it a question of diverting "energy" in another direction. The author has overlooked Sherrington's experiments which show that a reflex can be inhibited without evoking any other reflex. The reviewer must confess, however, that he is at a loss to understand what the difficulty with the cardiac vagus really is. We find also some unnecessary trouble made about "trigger action." The physiologist understands by this expression merely that the work required to set a process in action has no relation to that set free as a result. It may be that a measurable amount of work is needed to move a trigger, but the energy set free in the cartridge is just the same whether the trigger moves stiffly or easily. One would also like to have a little more explanation of what the author means by "shock" as applied to cells.

This list of criticisms may be ended with one of a different kind. On p. 169 it is suggested that there is an advantage in cannibalism owing to the fact that the food has a similar nature to the body of the eater. But we know that all food is completely broken up in digestion into constituents which are the same for all kinds of flesh, unless there be something present in minute quantity not yet discovered. But this is a very unlikely possibility, and has no evidence in its favour. There seems, then, to be no justification for the statement.

The book abounds in illuminating similes. As an example, one might take the comparison of enzymes or catalysts to the tools with which the cell works, and the nucleus to the tool-room; but the latter is more hypothetical.

What has been said will serve to show how great is the variety of subjects discussed; but a meagre impression has been given of the interesting way in which they are treated. Everyone who cares to put his ideas in order is strongly advised to read the book.

The author deserves our gratitude for providing an index. This is not always to be found even in works of a more special nature.

W. M. BAYLISS.

Life in the Misty Islands.

The Land of the Hills and the Glens: Wild Life in Iona and the Inner Hebrides. By Seton Gordon. Pp. xii+223. (London: Cassell and Co., Ltd., 1920.) Price 15s. net.

THIS beautiful book, fine in temper, style, and illustrations, discloses something of the charm of the Inner Hebrides, "the Land of the Hills and the Glens and the Heroes." Mr. Seton Gordon is a keen ornithologist and a master-photographer, but he is much more—a genuine lover of wild Nature. His pictures are at once realistic and sympathetic. In the early morning, on the top of Ben Nevis, he notices the meadow pipit picking little insects off the frozen surface of the snow, but he leaves the main impression salient—a vast sea of mist, changing from cold grey to rose, from amid which the tops of the highest hills stand out clear and sharp, all the rest of the land deeply submerged.

In a small glen "in the keeping of the great hills" a pair of golden eagles make their nest on one of the veteran birch trees. Mr. Seton Gordon had the good fortune to witness the first flight of the two eaglets, and gives us a fine description. He notices that when two are reared, one is always a cock and the other a hen. As the two eggs we have seen have usually been slightly different in colour, we wonder if this is an index of the future sex. Perhaps this is an old speculation. The scene changes to one of the misty islands when there is a first hint (in February) of the approach of spring—ravens somersault, oyster-catchers stand in the sun, companies of turnstones flit restlessly about, and many barnacle-geese rise up from their feeding. It is suggested in passing that the quaint story of the origin of these barnacle-geese from barnacles may have had something to do with the fact that the nesting site—in inaccessible districts of the High North—was until recently quite unknown. About the time the barnacle-geese return to the lone island after summering in the North, the baby grey seals are in possession, and a visit to the wild nursery in the first week in November enabled the author to make some interesting observations and to take some first-class photographs.

Many of us have had experience of the sea that surges round Ardnamurchan—"The Point of the Ocean"—but few have set foot on its weather-beaten surface. Though on the mainland of Scotland, it is scarcely accessible except from the Island of Mull. "On its cliffs the golden eagle has its home, and in former times the erne or sea eagle was wont to nest on its inaccessible ledges. On quiet days of early spring ravens sail and tumble above its rocks, and one may hear the shrill, mournful cry of the buzzard as she leaves her eyrie. Near by is the haunt of the wild cat, now a fast vanishing species in the Highlands, and as early as February she has been known to produce her young in the rocky cairns above the reach of the waves." On one of the low islands far to the west of this the Arctic skuas arrive from the south about the end of May. They are almost unique in their habit of feigning injury in order to deceive the intruder while the eggs are freshly laid. Many birds do this later on. From observations at his "hide" Mr. Seton Gordon satisfied himself that the skua, at any rate, does not count more than one. One of the Gaelic names for the skua means "squeezer" in allusion to the habit of extorting fish from other birds, and it is noted that "even a bird of such command of flight as the tern very rarely indeed succeeds in getting away from a skua—that is to say, with its fish still in its possession."

We are tempted to linger over the fascinating pictures—the "big glen" in Mull, with one stream flowing east and another west, with its ravens and buzzards and deer; the Hill of the Two Winds rising steeply from the Sound, where the sparse ptarmigan have such a keen struggle for existence (because of the hungry eggs of many gulls and crows) that the cock birds are silent during the nesting season, and the hens are very easily frightened from their nests; the snapshots of the densely peopled sea-pool through every month of the year; the deep lochan in a crater-shaped corrie with eagles sailing above its dark water; the glen of the herons, where one can see eight nests on one small tree (it is noted, by the way, that the heron sometimes feasts on frog spawn); the little islet of Erniesgeir, where the puffins have destroyed all the grass; a seal at Skerryvore playing with a large cod in the water as a cat with a mouse; a great company of Bewick's swans swimming restlessly backwards and forwards along a narrow lane on the freezing loch, trying to keep an open waterway; a flock of dozing whooper swans with their snowy plumage lit up by the moon; but we must stop, for the book is full of these delightful things, to read of which is like taking a holiday. We wish to express our admiration of the succession of seasonal word-pictures of the Western Highlands which form the closing chapters of the book. They form a text worthy of the extraordinarily fine photographs.

Many will enjoy the studies of particular birds, such as the fighting blackcock. "Their curious bubbling note never for one moment ceased, and every now and again, as two individuals struck at each other with their feet, they uttered a sharp hissing sound, reminding one somewhat of the crow of a cock partridge. I think that the more one watches blackcock at their fighting the more one must come to the conclusion that much of this is somewhat half-hearted, and appears to be indulged in mainly with the idea of putting in the time and relieving the birds of their high spirits of an early morning. Of course, combats in earnest do take place, and continue until one of the combatants is either killed or else put to flight." We suppose these tournaments vary in temper, for in the case of the only good show we have seen, the jousting was far from half-hearted, and there were numerous grey hens close by. Mr. Seton Gordon, whose experience is great, says: "It is rarely that the grey hens in any numbers frequent the battlefield. One often sees an odd bird there, or even two or three, but personally I do not think I have ever seen so many as even half a dozen watching the fighting of perhaps twenty cocks." Polygamy notwithstanding, he thinks that there are considerably more blackcocks than grey hens. We should like to hear more of this.

The ringed plover, called in Gaelic "the ptarmigan of the waves," arrive in the Western Isles with the first coming of spring. A glimpse of their courtship is given. "The lady on these occasions stands demurely by while the cock bird rises excitedly from the sun-warmed shingle, and, with curious, erratic flight—a flight that is almost bat-like—twists and tumbles, calling the while with soft and plaintive note. All the time his wings move with scarce half their usual speed, and this characteristic of the love-song of the waders—though I have not seen it set down in any book—is well marked also in the oyster-catcher and the golden plover, to mention only two at random." The newly hatched chicks, like the eggs before them, are very difficult to find in their natural surroundings. "When they crouch at the alarm call of their parents they are almost impossible to locate. It is then that the old birds show signs of very great alarm, and often make believe that they are injured, trailing along just ahead of the disturber of their peace, and perhaps waving a wing helplessly in the air, or lying motionless as though dead, in their efforts to decoy him from the vicinity of their young." Who can help envying Mr. Seton Gordon his close acquaintance with the very interesting red-necked phalaropes which nest by the lochans of one of the far western islands? In their solitude they seem to know no fear, for they allowed the naturalist to come within a few yards of them. "When on the water the red-necked phalarope rides with extreme buoyancy, and progresses rapidly. Its neck is long, and is held erect, and when it approaches the observer the russet-red markings on the cheeks and neck are strikingly handsome. Its call, too, is quite distinctive, a high chirruping cry, resembling no other call that I know of." Here, as elsewhere, the author refrains from comment on the biological peculiarities of the bird; we suppose he prefers simply to tell his own story in his own way, and we think his restraint is wise. The record has a sincere naturalness about it, and a very pleasing style. We wish that we had left space to say a little in regard to the author's references to the people of the islands. Here, as in his natural history, he has the insight that is bred of sympathy and scientific patience.

Modern Oil-finding.

Prospecting for Oil and Gas. By L. S. Panyity. Pp. xvii+249. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) Price 18*s*. net.

It is to be hoped that by now, when so much publicity is given in the Press to commercial oil undertakings (and, unfortunately, to many which are the reverse of commercial in the true sense of the word), the more intelligent public will have learned that "chance" is a relatively unimportant factor in modern oil-finding. Much of the present-day success of existing fields, and undoubtedly the prospects of ultimately locating new productive areas, lie in the application to oil prospecting of the more precise methods of geological survey. Such work can be carried out only by competent persons qualified to undertake a survey for oil, and this implies training of a highly specialised character. Those who have had any experience, therefore, in this branch of teaching will readily appreciate the value of a book such as Mr. L. S. Panyity has written, a book which must also make a wide appeal to the student and to the oil geologist of the older school.

Considered purely from the academic point of view, the volume can unhesitatingly be put into a student's hands at the outset of his course without any apprehension as to its suitability as preface to both lecture and practical work. From the composition and origin of oil and gas, their migration and accumulation, through all the intricacies of modern methods of surveying and prospecting, to the sinking of wells and the production of crude oil, the author takes his reader through a thorough course of elementary instruction without burdening him with unnecessary technical detail. The early chapters deal with general geological definitions, conventions, and successions, considered from the point of view of oil technology. From these we pass directly to actual field-work, initiated by a lucid exposition of plane-table survey, including the more exact processes in triangulation. In the succeeding chapters, dealing with actual maps, it is pleasing to note that the construction and reading of isobath and isochore maps receive adequate attention, as both these phases of the subject present difficulties to the novice at first, though we should have preferred that the question of the interpretation of geologic structures had received fuller discussion, even to the exclusion (if necessary) of the long chapter on fossil flora and fauna. Condensed palæontology or palæobotany is seldom a success, and with the great number of useful text-books available for studying these subjects such an omission would need no apology.

The remaining pages of the volume are devoted more to the engineering aspects of oil prospecting, and include chapters on the location, sinking, spacing, and completion of wells, together with some notes on regulating the course of production of the crude oil derived. A somewhat lengthy appendix contains some useful tables of constants for triangulation work, and also for calculating the capacities of gas wells, etc.

As is usual with American publications of this nature, the book is profusely illustrated with maps and diagrams, and the inevitable "Landscape and Topographic Contour Map" (depicted on the inside cover of all the folios of the United States Geological Survey) finds a place here on p. 70. It is undoubtedly an attractive and useful publication, which, by virtue of its clearness of diction, careful arrangement of subject-matter, and freedom from "padding," should make an appeal to a very wide public.

H. B. MILNER.

The Induction Coil of To-day.

Induction Coil Design. By M. A. Codd. Pp. vi+239+14 plates. (London: E. and F. N. Spon, Ltd., 1920.) Price 21*s*. net.

IT is only within the last few years that the induction coil has emerged from the sanctum of the philosophical instrument maker and even approximated to an electrical engineering "job." It cannot yet be said to have shaken itself free of the trammels of empiricism, and it too often serves largely as a medium for the skill of the cabinet-maker and french polisher to impress a susceptible *clientèle*. Moreover, for X-ray work at any rate (and in particular for work with the Coolidge tube), the interrupterless transformer is finding fresh adherents each day, and it was high time that the case for the induction coil should be put by one who is conversant with coil construction and design.

Mr. Codd candidly concedes at the outset that precision measurements of coil phenomena are difficult, if not impossible, and as a consequence present-day design rests mainly on arbitrary standards which have been evolved empirically from practical experience. Holding the view that a knowledge of these standards should not be confined to the coil-maker, Mr. Codd has accordingly collected data from his experience of a number of typical and accepted designs, and set them out comparatively in the present book. To the coil-maker the wealth of practical and diagrammatic detail should be of value; and even the user, primarily concerned with performance, will be interested to learn of the constructional precautions and skill which have to be exercised, and of the relative common-sense values of the several designs on the market, for each of which extravagant claims of super-efficiency have usually been advanced by its author.

Here it may be remarked that the efficiency of even a large coil rarely reaches 50 per cent., and is usually nearer 30 per cent. Nor can the same coil be equally efficient for all purposes. It is in the success with which he reconciles antagonistic factors that the coil-maker's art finds its greatest expression. He knows, as a practical fact, that for a given transformation ratio the secondary winding should be such as to keep the self-induction as low as possible; he has found that for X-ray work the condenser capacity should be as small as is consistent with preventing undue sparking at the interrupter; and he has grown to realise that the design and performance of the interrupter are all-important and may enhance or undo his work on the coil.

There are certain other features which the coil-maker has learnt to incorporate in his design. He allows for each kilo-volt-ampere input about 15 lb. of iron core, of which he makes the length from six to ten times the diameter. He winds the primary so as almost to cover the whole length of the core, but he keeps the length of the secondary down to about three-quarters the length of the core, and finds that the diameter of the secondary should not exceed about 2·5 times its bore. Among many other guiding facts, he estimates to get about 4 kilo-volts from every 1000 turns in the secondary, knowing also that a transformation ratio in the region of 100 to 1 is a practicable figure.

All this and much besides is to be found in Mr. Codd's book. He supports many of his contentions with the help of a large number of oscillograph records. We regret to find no mention of Prof. Taylor Jones's work, but we gather that the book is limited to the author's own experience. There is a useful bibliography, but no index.

Our Bookshelf.

The Romance of the Microscope. By C. A. Ealand. Pp. 314. (London: Seeley, Service, and Co., Ltd., 1921.) Price 7*s.* 6*d.* net.

To the well-known "Library of Romance" Mr. C. A. Ealand contributes a volume on the microscope. He gives a glimpse of the early days of invention, of pioneer microscopists such as Leeuwenhoek and Hooke, and of the principles of the instrument. He then illustrates the use of the microscope in studying the life of ponds and streams (but why call the amœba "a free swimming denizen"?), the structure of plants, the structure of animals (in the course of this investigation, "Having taken our fill of the spiders' feet we may well turn our attention to their heads"), sections of rocks, impurities of food, bacteria, blood, rusts on leaves, small insects and parts of insects, and so on. We are sometimes forced to doubt the author's sincerity, as when he says that if we put the liver-fluke under the microscope "we can plainly see all its internal organs." That has not been our experience, nor anyone's. Similarly, we are not pleasantly impressed by being told that *Demodex folliculorum* (or, as the author has his specific names printed throughout, *Demodex Folliculorum*) is to be found in the sweat-glands. The book ends with more practical matters: the micro-telescope and super-microscope, chemistry and the microscope, the use of the microscope in manufacture, the camera and the microscope in alliance, the glass used in making lenses, and the choice and use of apparatus.

We think the book will help to diffuse an interest in microscopy, which, of course, means the discovery of a new world and of a new joy in life; but we wish the author had shown more microscopic precision in his workmanship. He tells us that, having found our sea-slug or sea-cucumber, especially the species called *Synapta Inhaerens*, we find by touch that its leathery skin is studded with some flinty matter, which we go on to verify under a low magnification. And so *passim.*

Organic Chemistry for Advanced Students. By Prof. Julius B. Cohen. Third edition. Part i., *Reactions.* Pp. viii + 366. Part ii., *Structure.* Pp. vii + 435. Part iii., *Synthesis.* Pp. vii + 378. (London: Edward Arnold, 1920.) Price 18*s.* net each volume.

THAT a reprint of the above work should be called for in just over a year after the publication of the last edition is clear evidence, if such were needed, of the value of the book; it may further be taken as welcome proof that there exists a large circle of serious students who are not content to acquire their knowledge in "tabloid form," but are prepared to work through a three-volume treatise on advanced organic chemistry. The book has an important mission to fulfil in imparting a sound knowledge of the principles underlying the modern developments of organic chemistry to the rising generation of chemists, and, from the rapid exhaustion of the last edition, one may conclude that it is successfully accomplishing this.

The present edition calls for little detailed comment, since no material changes have been made in the text, the author having confined himself to adding a number of references to recent literature, which will enable the student to bring his information up to date.

Leicestershire. By G. N. Pingriff. Pp. xii + 164. (Cambridge: At the University Press, 1920.) Price 4*s.* 6*d.* net.

AN interesting description of the many features of interest in Leicestershire is given in this book by pen and photograph. In the opening chapters the position, general features, rivers, and watersheds of the county are described. Its geology, natural history, and an account of its climatic conditions follow. Four chapters are then devoted to the people of Leicestershire and their industries, stress being laid on the increase of grassland as opposed to arable farming. The remainder of the book deals with the history and antiquities of the county, and the concluding chapter is a useful index to its chief towns and villages. Instructive diagrams, showing graphically the proportions of the acreage of the principal crops, form a brief appendix. The book is throughout well illustrated by interesting photographs and sketch-maps.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Science and Fisheries.

THE two letters from Prof. McIntosh and Mr. H. G. Maurice published in NATURE of December 30 last are of great interest. The second points out that an arrangement is now in operation by which the scientific staffs of the English, Scottish, and Irish Fishery Departments are arranging to meet at regular intervals to frame their scientific programmes; and the first refers to the responsibility of the Departments "in selecting for the task scientific men whose training and ability specially fit them for the complex work."

It may not be generally known that the real controlling authorities so far as fisheries research is concerned are the Development Commission and the Treasury. The Development Commission considers all applications from any of the three Departments for funds to carry out the researches that may be proposed. This consideration is not merely an office matter, for the proposed researches are considered by a special Committee, mainly of scientific men, presided over by Mr. W. B. Hardy. This Committee has already presented several excellent reports, and generally fresh applications for funds are referred to it. While the Development Commission is thus responsible for the work to be undertaken by the different Departments, the Treasury is responsible for the supply of properly trained scientific men to carry out the actual work. The real onus is on the Treasury, for the payment of all men in the service of the State is reviewed by this Department when providing funds for their payment. We have, on one hand, a body expert both as to the nature of the work proposed and as to the supply of men properly trained to carry out this work; and, on the other, a body with no qualifications whatever to review the work and no special knowledge as to the conditions of pay in different branches of science, especially in biological sciences. It appears to me that the present arrangement is not businesslike, and would not be tolerated in any commercial firm.

The Fishery Departments of the three countries certainly have progressed to a very considerable extent, and it is surely a peculiarly favourable time for a further step in progress. It is generally agreed that the research in fisheries of the three kingdoms should be carried out on one scheme; at present the Departments of Scotland and England are without any scientific directors. Surely the time has come when the scientific work of the three countries in respect to fisheries should be placed under one Director of Fishery Investigations and the three separate scientific staffs should be merged into one. The control of this Scientific Fisheries Division could obviously not be placed in any one of the Fishery Departments, and would have to be assumed by the Development Commission. The latter could act through an Advisory Committee on which the three Departments could be represented, if it is deemed advisable to do so. The Committee might also contain representatives of the different branches of the industry. There would be no competition between the three countries for such scientific men as are available or in respect to the mere numbers of their so-called scientific employees. The one body would be responsible for the work and for the human material necessary to carry out that work; the result, I venture to suggest, would be greatly to the interest of the country and would ensure good value for the money spent. The fisheries form an industry and the public are the consumers; the staffs which exist to protect and develop the interests of both should obviously be under one head.

My own experience of the three Fishery Departments of England, Scotland, and Ireland and of the industry has been altogether pleasant and decidedly "happy," and I am under obligations to the Development Commission as well. I resigned from the English Department on November 30 last because the Treasury declined to give us a staff of such a nature as I deemed necessary to carry out the work proposed. The Treasury, in fact, took from me the possibility of recommending to the Fisheries Secretary a staff capable of doing this work; it offered a lower rate of pay than the higher grade of the Civil Service, with a prospect of promotion from the lowest grade to the next at the age of forty-three or thereabouts, whereas the Civil Service has a prospect of similar promotion about ten years younger. The Treasury instituted a scale of pay in all the four grades of the Scientific Division of the Ministry distinctly lower than that of a higher grade of the Civil Service; in fact, it proposed to create a fresh grading of inferior rank, with very indeterminate prospects of promotion. Apparently the Treasury was doing this on general grounds—the inferiority of scientific men to the ordinary Civil Servants employed by the State! It certainly could not have had the advice of any biologist as to the supply of the men available for the work.

What is required in fisheries is the scientific man who is broadly trained in the relationship of fish to the chemical and physical conditions of the water in which they live, to the biological conditions of the organisms with which they are associated, and ultimately to the biological conditions in relation to the floating plant-life upon which all water-living animals to a considerable degree depend. The successful fishery investigator must be, as it were, a "medical man" who has fish as his speciality instead of human beings; he has to consider every factor in respect to the living fish just as the practitioner has to consider every factor in respect to his patients; he must even know something of statistics. The number of such men is small, but they may be "created" if there are openings for them. The training involves many years of hard study, but no amount of training will compensate for an absence of the requisite ability to visualise and correlate all the different factors that are involved in studying the living fish.

The men who give up their time and thought to such a study put themselves outside the branches of science that are recognised in our different universities. By so doing they renounce the beaten tracks of ordinary scientific promotion and their prospects therein. The responsible heads of scientific departments in universities cannot recommend their best men to do this unless they see adequate possibilities for their future. By the creation of a single strong Division for the scientific investigation of British fisheries under the Development Commission, adequately paid and with prospects of promotion at least equal to those in any university of the kingdom, there would be a great inducement to the best men to undertake this work; its very complexity would attract them. As it is, there are three Scientific Divisions of Fisheries under three different Departments the positions and prospects in which are not such that the best men can be recommended to them; these three Divisions at present have, I venture to suggest, sufficient first-class men to fill adequately the higher posts of the proposed single Scientific Fisheries Division, and it can be recruited to full strength as men of the requisite ability become available.

As a professor in a great university I cannot recommend my first-class man—I do not refer merely to a first-class degree—to apply for a post in research in the service of the State which is inferior to that of the higher grade of the Civil Service. The mental qualifications for research posts are far rarer than for the ordinary work of administration. The holders of such posts cannot be transferred from department to department, so that proper recognition must be guaranteed them from the start. All of us must cordially endorse the resolution unanimously passed by the council of the British Association: "That the council considers that no scheme of payment of professional scientific men in the service of the State is satisfactory which places them on a lower level than that of the higher grade of the Civil Service." If science is to work for and with the State the Treasury must cease treating its scientific as inferior to its administrative services. There are difficulties, of course, in blending the two services, for science will be killed if it becomes bureaucratic; at the same time it must not be allowed to become an underling to the present bureaucracy.

In conclusion, it is interesting to note that while the administrative staffs of the fishery departments of most civilised countries are recruited almost solely from men who have been trained in science, that is not so in this country. The tremendous development of Norwegian fisheries is obviously due to one man, who was first and foremost always a scientific man. The great development in Germany before the war was due to scientific men. The employment of fishery officers who have some knowledge of the conditions of life of the living fish is obviously of primary importance. The users of trawlers and the herring drifters are increasingly taking more and more interest in the lives of their prey, and the Fisheries Departments should not merely follow their lead, as they will ultimately have to do, but should also, as in other countries, seek for inspectors who, at any rate, have the fundamental scientific knowledge upon which alone deductions as to the fish with which they have to deal can be made profitably. Every inspector should surely be able to answer from his own knowledge the ordinary points raised in respect to the lives of commercial fish and in respect to the possibilities of deterioration and pollution on their way to market. The training for such is that broad training in science which is provided in all the greater universities of the kingdom, and the Departments need feel no fear as to the lack of competition for their posts if they adopt the right scheme.

J. STANLEY GARDINER.

Zoological Laboratory, Cambridge,
January 8.

The Central Meteorological and Geodynamic Institute, Vienna.

THE Central Meteorological and Geodynamic Institute in Vienna is the oldest meteorological institute in the world. It was founded by the Austrian State in 1851, at the request of the Vienna Academy of Science, with the object of developing the study of meteorology and terrestrial magnetism, and for the past seventy years has served both science and practical life.

In consequence of the war and the subsequent peace the future activities of the institute are in jeopardy. The impoverished little Republic of Austria has not the necessary means for carrying on the work of the Central Institute.

The undersigned feel it their duty, as former and present directors of this old institute, to inform the meteorological institutes, societies, and men of science all over the world who have any scientific or practical connection with the Central Institute in Vienna and exchange publications with it, of the pressing need of the Central Institute.

In acting thus they take the point of view that a scientific institute like the Central Institute is, to a certain degree, the public property of all the cultured nations of the earth, and as such these are all interested in its existence. The undersigned therefore plead for financial aid for the Central Institute.

The low value of the Austrian kroner (less than two Swiss centimes) makes it, on the one hand, easy for foreign States to help, but, on the other, the Austrian State endowment, in spite of repeated increases, is ever insufficient.

The Central Institute can now no longer publish its year-books, even for diminished Austria, although the yearly printing expenses would only be 1000 Swiss francs. The year-books, however, as they contain the results of observations—that is, definite facts—represent the basis of the development of our science.

It is, moreover, impossible for the Central Institute to carry on its work. It has become impossible to procure instruments; hydrogen for pilot-balloon ascents is too expensive; and the same applies to rubber balloons for recording ascents. It is impossible to keep the library up to date, as the smallest foreign books or journals cost hundreds of kroner. Consequently, meteorologists cannot follow the trend of work abroad and so keep up with the times.

It will be possible to issue the weather charts for six months more, until the stock of paper is exhausted, then this issue must cease. It will be possible with difficulty to keep up the seismic observatory in Vienna; the stations at Grätz and Innsbruck must, on the other hand, be given up, as the expenses of running them are too heavy. There can be no question of recommencing the registration of terrestrial magnetism which was carried out at the high-altitude station at Obir before the war.

No matter where we turn we find the same cheerless decay.

We refrain from enlarging on the *rôle* which the Austrian school has played in meteorology during the last fifty years. We venture, however, to name a few books which have emanated from the Central Institute of Vienna:—*Meteorologische Zeitschrift* since 1866; J. Hann, "Handbook of Climatology"; J. Hann, "Text-book of Meteorology"; J. M. Pernter, "Meteorological Optics"; W. Trabert, "Text-book of Cosmical Physics"; and F. M. Exner, "Dynamical Meteorology." We beg that foreign States will remember the Central Meteorological Institute in Vienna from the titles of these books, and that help may be forthcoming.

F. M. EXNER,
Present Director.
J. HANN,
Former Director.

Vienna XIX, Hohe Warte 38, December 2.

Tidal Power.

ESTIMATES of the power to be obtained from the rise and fall of the tide are often greatly in excess of practical possibilities. If it is assumed that an estuary or reservoir of area A is enclosed by a dam at the outer face of which the difference of level between high and low water is H, then (w being the weight of the unit cube of water) the work which might conceivably be extracted from tidal action is $w.A\frac{H^2}{2}$. To attain this end the relation between the water levels outside and inside the dam must be that shown in Fig. 1 by the full and dotted lines respectively. The motors or turbines must be designed to work efficiently with any head from 0 to H, and able to do all the work in such a short time that the high and low water levels remain practically constant during that interval, say 20 minutes.

If the interval between high and low water is six hours, the motors must be capable of delivering eighteen times the average power, and of this power 17/18 must be stored. It is, of course, impracticable to fulfil these conditions. The turbines have to work with a nearly constant head, and it would be impossible to arrange for the whole work to be done in the short time available at high and low water.

The most practicable plan is indicated in Fig. 2. The flow through the turbines is adjusted to reduce the rise and fall inside the dam to half that of the

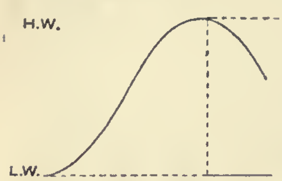

FIG. 1.

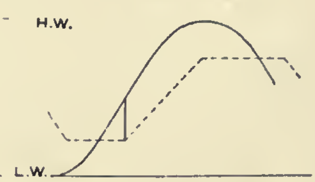

FIG. 2.

tide and the time of working increased to about three hours. The effective head is H/4, and the distance through which it acts (*i.e.* the stroke) is H/2. In this way about one-fourth of the tidal energy $\left(w.A\frac{H^2}{2}\right)$ might be utilised, half of which would have to be stored if the power supply is to be constant. Taking into account the various losses due to turbine, electrical, and storage efficiency, it is improbable that more than one-fifth of the whole tidal power could be delivered as electric current.

If A is 1 square mile and H 30 ft., it will be found that for each square mile of reservoir surface something more than 10,000 h.p. might be expected.

I have no knowledge of the details of the Severn scheme, but if it were possible—which I doubt—to enclose 20 square miles of estuary where the average difference of tidal level was 30 ft., the power available for distribution would be under 250,000 h.p.

It may be remarked that the same power could be obtained from a river having a current of little more than 2 miles per hour and a cross-sectional area of 2000 ft., if in its course there was a fall of 30 ft.

A. MALLOCK.

Heredity and Acquired Characters.

IN NATURE of January 6 there appears a long communication on heredity by Sir Archdall Reid which he conceives to be a reply to criticisms made on a former letter by him on the same subject by Sir Ray Lankester, Prof. Poulton, Dr. Gates, and myself. Leaving these eminent biologists to look after themselves, which they are quite capable of doing, perhaps you will allow me to say a word or two on some points raised in the letter in the current issue.

Sir Archdall Reid accuses me of torturing "a word which has now an established and perfectly clear meaning." The word is "variation." I wished to contribute to clearness by defining it, for, so far from its having a clear meaning, there are at least three senses in which it can be used. Further, let me say that if a five-fingered child were born of a six-fingered parent, I should not describe it as a "variation," but as a "reversion."

Next, Sir Archdall Reid challenges me to define the "quibble" about "acquired character." "Acquired character" is a technical term; by it is meant a quality, *i.e.* the degree of development of an organ, which is produced as a response to function, altered from the normal in response to an alteration of the environment from the normal; but Sir Archdall Reid interprets it as any adult character whatever.

Sir Archdall Reid has, however, understood the point, because he says that "the supposition that 'acquirements' tend to become 'innate' is . . . ridiculous." Such an *ex cathedra* statement contributes nothing useful to the discussion. There are definite experiments on record which, if true, prove this very point, but Sir Archdall Reid apparently knows nothing about them.

Then we are told that "low in the animal scale we find little or no evidence of development in response to functional activity." On reading this the question that instantly occurs to one's mind is: "Where did Sir Archdall Reid learn his zoology?" I have been working with Echinoderm larvæ for many years, and in no animals known to me is structure more sensitive to changes in the environment (Proc. Roy. Soc., B, vol. xc., 1918).

Lastly, Sir Archdall Reid says: "We are now in the morass in which Lamarck and Weismann floundered." I have attended many congresses of biologists, and I have never found evidence of confusion in their minds as to what was meant by an "acquired character." They differed, and continue to differ, as to whether there is evidence that an "acquired character" can be inherited, or, to use Sir Archdall Reid's paraphrase, that "acquirements" can become "innate," and this difference can be settled only by the outcome of experiments which are now in progress, but I have nowhere detected evidence of a condition of thought that could be described as a "morass." I conclude, therefore, that it exists alone in Sir Archdall Reid's mind. E. W. MACBRIDE.

Imperial College of Science and Technology,
South Kensington, S.W.7, January 7.

PROVIDED that biologists understand one another, it is, perhaps, not an insuperable barrier to the progress of biology that Sir Archdall Reid is unable to understand their terminology. I write merely to point out that though he seeks to teach biologists the proper use of terms, Sir Archdall Reid, in his letter in NATURE of January 6, contradicts himself in his own terminology. He states that even in human beings many characters do not develop in the least in response to functional activity, *e.g.* hair and external generative organs. On the other hand, in man most characters develop wholly, or almost wholly, in response to that stimulus. Yet in another paragraph he asserts that all characters are necessarily innate, acquired, germinal, somatic, and inheritable in *exactly the same sense and degree.* If biologists recognise, as Sir Archdall Reid does, a difference between characters that develop in response to functional activity and those which do not, what need is there for him to ask biologists why they describe some characters as "innate," "germinal," and "inheritable," and others as "acquired," "somatic," and "non-inheritable"? J. T. CUNNINGHAM.

University of London Club, 21 Gower
Street, W.C.1, January 7.

Solar Radiation in Relation to the Position of Spots and Faculæ.

ABOUT September 1 last an arrangement was made between the Director of the Argentine Meteorological Service and the Director of the Astronomical Observatory of the University of La Plata for observations of disturbances visible on the surface of the sun, including spots and faculæ to be recorded on a diagram of the sun's surface and transmitted to the Meteorological Office for the purpose of comparing them with the observations of solar radiation received from the Smithsonian Solar Observatory at Calama, Chile.

The observations at first consisted chiefly of a record of sun-spots, and although the time is short the relation seems so apparent as to be worthy of record. The records have been arranged in three series, two of which are practically independent of each other and the third partly so.

The first series was derived from seven groups of sun-spots by taking the day of their first appearance on the east edge of the sun three days before and five days after, and obtaining the average values observed of solar radiation on these days in calories per square centimetre.

The second series was derived from six groups of sun-spots by taking out the mean solar radiation on the last day of visibility and for five days preceding and three days following.

The third series was derived from seven series of spots by taking the mean solar values on the days the spots crossed the solar meridian and for eight days preceding and eight days following.

The results are shown in the following table:

Mean Radiation Values for Different Positions of Sun-spots.

(1)	Days before.		East edge.	First seen.	Days after.				
	2	1	0	1	2	3	4	5	6
Radiation	40	24	45	55	52	48	37	47	39

(2)	Days before.					Last seen.	West edge.	Days after.	
	6	5	4	3	2	1	0	1	2
Radiation	46	45	35	30	48	50	54	40	38

(3) Days before.								Meridian	Days after.							
8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8
42	38	40	49	41	48	33	46	44	45	35	47	40	49	46	40	38

The mean solar radiation value is formed by adding 1·900 to the values given in the table.

As the spots are rarely seen exactly on the edge of the sun, the day on which they are first seen is numbered 1, and the day before is numbered 0; also, when last seen the day is numbered 1, and the day after 0.

The mean solar values during the interval covered by the observations is 1·943, so that on the day when the spots were first seen the radiation averaged 0·012 calorie above normal, and when last seen 0·007 calorie above, or in the mean about ½ per cent. of the solar radiation.

There was one day common to the two series when spots were visible on both edges of the sun at the ends of a diameter passing through the sun's centre, or, in other words, on a great circle about 180° apart. On this day the solar radiation value was 1·969, or more than 1 per cent. above normal.

The grouping around the central passage of the spots does not bring out the relation so distinctly, although higher values are found five days before and five days after the passage across the meridian, the lowest values being found two days before and two days after the central position. If one takes the mean of the five days about the centre, including two days before and two days after the central passage, a value of 1·941 is obtained, which is slightly below the normal value, as if some absorption of heat resulted from the central passage of the spots.

These results have an interest in connection with the fact that Dr. Abbot found a decrease in the contrast of brightness between the edge and centre of the sun coinciding with short-period increase of solar radiation (Smithsonian Miscellaneous Collections, vol. lxvi., No. 5). Both these results can, I think, be explained in the same way. It is well known that solar faculæ and solar eruptions surround regions where spots are numerous.

These eruptions when seen near the edge of the sun tend to decrease solar contrast and to increase the total solar radiation. On the other hand, when they are near the centre of the sun they are seen directly above the hotter gases from which radiation is coming vertically through the sun's atmosphere, and hence is not greatly absorbed.

The cooler gases within the spots may even absorb more of this radiation than is made up for by the increased radiation of the faculæ in the outer atmosphere.

The results, if confirmed by more extended observations, will also have an important meteorological bearing. Numerous investigators like Loomis, Veeder, Arctowski, and Huntington have found evidences of increased solar influences on the earth's atmosphere when the solar spots were near the edge of the sun. E. Huntington especially has made an extensive investigation of the position of the solar spots as related to the storminess in the North Atlantic, and has found that the most marked effects are shown when the spots are near the edge of the sun, and hence when there is probably increased solar radiation (Monthly Weather Review, U.S.A. Weather Bureau, March–June, 1918). H. H. CLAYTON.

Buenos Aires, November 6.

Odours Caused by Attrition.

THE unpleasant odour which attends the attrition of pebbles, etc., appears to have been noticed at a much earlier date than any mentioned by previous correspondents. Robert Boyle ("The Efficacy of Languid Motion," Works, edited by Boulton, 1699, vol. i., p. 234) remarks: "And that it may further appear, that a peculiar Modification of Motion, may contribute to the various Effects produced by it, I shall observe, That those Stones which *Italian* Glassmen make use of [quartz?], afford Sparks of Fire by Collision; but if moderately rubb'd together, they emit *fœtid* Exhalations; from whence probably proceed those offensive Steams, emitted by Glass; and what is more remarkable, and to our purpose is, tho' Glass when Red-hot emits no such *Effluvia*; yet if two pieces be dextrously rubb'd together, they will send forth Steams copious enough and *fœtid*."

It seems to me that there are at least two suggestions not brought forward by previous correspondents in NATURE contained in Boyle's observations, both of which might well be followed up experimentally. The implicit explanation of the cause of smell is also of some interest. J. R. PARTINGTON.

Lostock Gralam, Cheshire.

The Energy of Cyclones.

I SHALL be glad if you will allow me to refer briefly to the objection Mr. W. H. Dines raises to my theory of cyclones (NATURE, December 23, p. 534). Mr. Dines remarks that if "cyclones are caused by an access of warmth in the stratosphere . . . the troposphere ought to bulge upwards over the cyclone, whereas, in fact, it bulges downwards." My view is that where the stratosphere is warmest it must be thickest, and the troposphere must be thin. As the warmest portions of the stratosphere are at cyclonic centres, the lower boundary of the stratosphere must bulge downwards over such areas and the troposphere be correspondingly thin. I assume that the heat of the stratosphere passes downwards so rapidly that the slowly rising air cannot maintain the troposphere at its normal thickness. R. M. DEELEY.

Tintagil, Kew Gardens Road, Kew, Surrey, December 24.

Nature of Vowel Sounds.

By PROF. E. W. SCRIPTURE.

The Analysis of Vowel Curves.

SINCE the time of Wheatstone and Helmholtz the vowels have been almost universally supposed to obtain their tones by acting as resonators to certain overtones of the larynx tone. Helmholtz even constructed an apparatus of a set of harmonic tuning-forks by combinations of which he hoped to produce the vowels. Ever since the invention of the speech-recording machine by Scott and Koenig in Paris the analysis of vowel curves has been expected to solve the problems of the nature of a vowel and of the differences between different vowels.

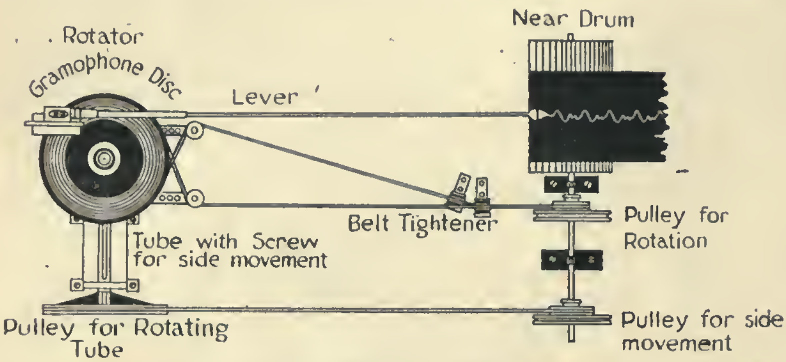

FIG. 1.—Apparatus for tracing gramophone curves. A steel needle near one end of a long lever follows the groove. Its movements are enlarged 500 times and registered on a band of smoked paper.

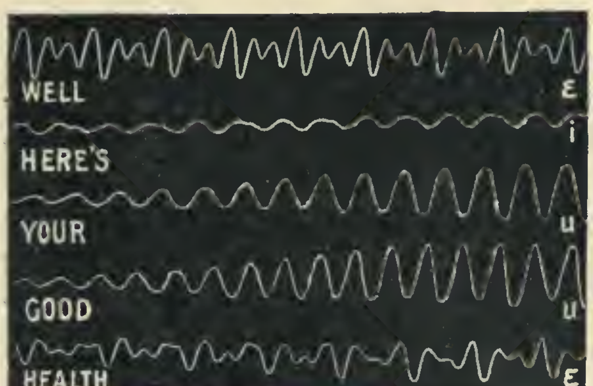

FIG. 2.—Vowel curves. The waves fall into groups; the top line contains eight groups, the next line six, the third seven, the fourth eight, and the last seven. Each group corresponds to one vibration from the larynx. The length of a group gives the pitch of the laryngeal tone; in speech this is always rising or falling. The height of the waves indicates the intensity. This is nearly always small at the beginning of a vowel; there is a steady rise to a maximum and then usually a fall to the end. The small waves within a group give the characteristics of the vowel sound. The top line is a piece out of the middle of the vowel in "well." The second line is from the vowel in "here." The third is near the beginning of "your." The fourth is the first part of the vowel in "good." The last is from the middle of "health." In the second, third, and fourth cases there is evidently present a tone more or less nearly the octave of the laryngeal tone. The other tones and the tones in the other cases can be found only by analysis.

At the present day the vowels can be recorded on talking machines, and their curves can be traced off with an accuracy that leaves nothing to be desired. The work of Hermann on the curves of the vowels and consonants by means of the phonograph is still unsurpassed. For my own investigations the gramophone was chosen as the most available machine.

A disc with the desired record was placed on a very slowly revolving plate (Fig. 1). A long lever of Japanese straw was held in an axle at one end. Near this end a steel point projected downward into the speech groove. At the other end there was a recording point made of a fine glass thread. As the disc revolved, the movements were magnified—up to 500 times—and traced on a moving band of smoked paper.

Pieces of vowel curves cut out of a tracing of a record by Joseph Jefferson are shown in Fig. 2. The curves show that in speech the vowels change constantly in pitch, in intensity, and in character. They also show that the vowels actually used in speaking are often not what the phonetician supposes them to be.

The point of interest on the present occasion, however, is the nature of a single wave of a vowel. At the present day there is only one way of analysing a wave—namely, the harmonic analysis. Any wave can be represented as made up of a series of simple sine waves with the relations of frequency of 1 : 2 : 3 : . . . and with various amplitudes. A harmonic analysis of the wave in the top line of Fig. 3 gives the four curves in the lines below. This means that the four curves, if added together, will give a result like that in the top line.

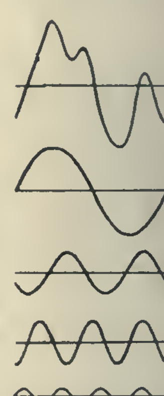

FIG. 3.—A curve composed of four sinusoids.

Suppose, now, that we have a curve that consists of a vibration repeating itself every $3\frac{1}{2}$ times to a wave. The harmonic analysis gives as result a fairly strong fundamental of the frequency 1, a stronger vibration of the frequency 2, a still stronger vibration of the frequency 3, a somewhat less strong vibration of the frequency 4, and ever-lessening vibrations of the frequencies 5, 6, 7, etc. Not one of these vibrations was actually present in the original curve. The strength of the original vibration of $3\frac{1}{2}$ could not be directly given, because there was no place for it in the harmonic series.

The harmonic analysis shows us how a given curve can be represented as made up of a series of harmonic components; it does not say that it was originally so produced. Such a deduction has to be made on other grounds. The familiar experiment with a piano string touched lightly in the middle, then at one-third of its length, etc., shows that it vibrates in harmonic parts; an analysis that gives the harmonic components in various amplitudes can be accepted at once as indicating the strength of the components. An analysis, however, that gives all the harmonics as being present to some degree with a bunch of strong ones at one or more points would indicate at once that one or more inharmonics were present.

A harmonic analysis of the wave in Fig. 4 from the first vowel in "Marshall" gives the harmonic plot shown in Fig. 5. This merely states that the original wave can be reproduced by using harmonics in the relations indicated. The deduction concerning how the wave was originally produced is left for the person who interprets the harmonic plot.

If such a result were obtained for a wave from a musical orchestra, we should have no hesitation

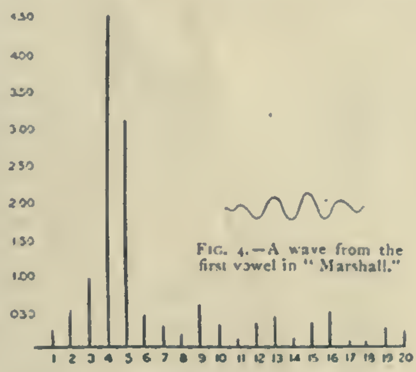

FIG. 4.—A wave from the first vowel in "Marshall."

FIG. 5.—Relative amplitudes of the sinusoids found by harmonic analysis.

in concluding that the wave was produced by a summation of vibrations in the harmonic relation. If the wave originated from a single source, we should certainly not be justified in drawing the same conclusion without further evidence. In seeking for further evidence we find, in the first place, that the waves from musical instruments so far as yet studied—the material is extremely limited—do not give harmonic plots like that in Fig. 5, and do give plots having one, two, or three prominent harmonics with the others lacking. This would agree with the known fact that most musical instruments vibrate in harmonics. If the source of the wave were absolutely unknown, the most plausible deduction would be that it was some body or bodies that might vibrate in either harmonics or inharmonics. We should take the weighted means of the groups of strong harmonics, and should find in this case that the components were the inharmonics

$$1 : 4{\cdot}3 : 9{\cdot}3 : 11{\cdot}5 : 17{\cdot}6 : 19{\cdot}5.$$

The result can be expressed in the inharmonic plot in Fig. 6. This conclusion is of vital importance, because such results are just those that are always obtained from careful vowel analyses. The very harmonic analysis itself leads to the conclusion that the vowel tones may be inharmonic.

In the analyses of vowel waves the fundamental is indicated as weak (as in Fig. 5) or often almost lacking. This fundamental represents the voice tone or the tone from the larynx. We all know that this is the strongest tone of all. We may not be able to hear just what vowel a speaker or singer is producing, but we certainly know whether he is using a high or a low tone of voice. One writer, observing this peculiarity in the analysis of the waves obtained from a phonograph, remarked that this instrument must be deaf to the voice tone. He failed to consider that if it was deaf to this tone it could not reproduce it, and that even the most defective phonograph will produce the voice tone so long as it makes any noise at all. The weakness of the fundamental in Fig. 5, therefore, does not show that

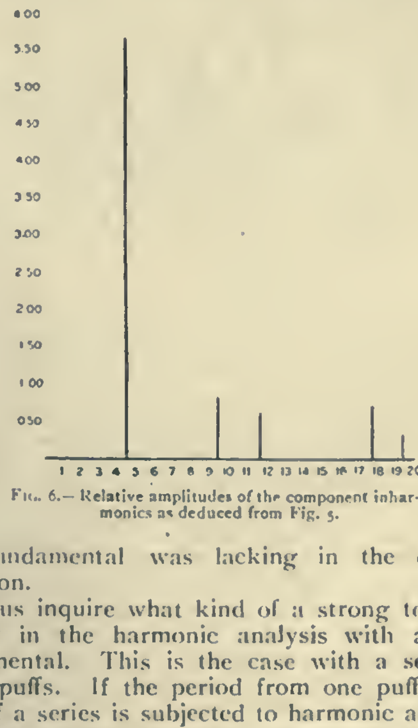

FIG. 6.—Relative amplitudes of the component inharmonics as deduced from Fig. 5.

the fundamental was lacking in the original vibration.

Let us inquire what kind of a strong tone will appear in the harmonic analysis with a weak fundamental. This is the case with a series of sharp puffs. If the period from one puff to the next of a series is subjected to harmonic analysis, the result shows a weak fundamental with all the higher harmonics represented in ever-diminishing amplitudes. The fundamentals in the vowel curves are therefore not of the nature of sine vibrations, but of series of more or less sharp puffs.

This is not a new theory of the vowels. In 1830 Willis published, in the Transactions of the Cambridge Philosophical Society, a paper on the tones of the vowels and reed organ-pipes. He asserted that a vowel was composed of a series of puffs with a set of inharmonic overtones. This was rejected in favour of the harmonic theory by Wheatstone, whose conclusions were accepted and developed by Helmholtz. For nearly a century the harmonic theory has been universally accepted.

In a series of researches beginning in 1889 Hermann found that the analyses of phonograph curves showed the vowels to be constructed of puffs and inharmonics. He thus independently rediscovered the principle of Willis. This theory has been substantiated and developed by thousands of analyses in my work for the Carnegie Institution of Washington, and published in "The Study of Speech Curves" (Carnegie Inst. Publ. No. 44), from which the above results are taken. It should be added that this extensive and somewhat expensive work was made possible by the support of Yale University and the liberality of the Carnegie Institution of Washington.

(To be continued.)

Nitrate Supplies and the Nitrogen Industry.

THE Imperial Mineral Resources Bureau has recently issued a report on the nitrate industry of the British Empire and of foreign countries, containing all available statistics with regard to the production and prices of nitrates during the war period. In conjunction with this report may be considered a paper dealing with the nitrogen industry contributed by H. E. Fischer to the Journal of the Franklin Institute (August, 1920, vol. cxc., No. 2). This paper gives a comprehensive survey of the sources of the world's nitrogen supply, particularly as it affects America. Nitrogenous compounds are absolutely necessary to agriculture, to the manufacture of munitions, to refrigeration, and to the general applications of chemistry, and although nitrogen in its inert gaseous state forms four-fifths of the atmosphere, yet this is of no use for the above objects until it has been combined or "fixed" by some method.

In the combined form, nitrogen is found in Nature as mineral deposits, as organic compounds, and in carboniferous deposits. By far the most important of the mineral deposits are those of Chile. Before the war the greater part of the world's requirements in respect of nitrate and nitric nitrogen was met by the export of nitrate of soda from Chile. The Chilean nitrate industry is one of long standing, and expanded steadily from 100,000 tons per annum in the middle of the nineteenth century to 2,400,000 tons in 1913. It has been stated that the Chilean nitrate deposits are nearly exhausted, but according to the Chilean Nitrate Committee's report "there is no fear of the Chilean nitrate deposits being exhausted for 200 years." The nitrate occurs as scattered deposits in a formation known as caliche, consisting of a conglomerate of rock material cemented with a mixture of soluble salts, in which sodium chloride is the chief constituent as regards quantity, while sodium nitrate is second. It is only in scattered patches that the caliche contains nitrate in quantities large enough to warrant treatment. These patches are sought out and excavated, and the picked ore is hauled to the extraction plant, where the soluble salts are extracted in solution, and the nitrate is separated from the other salts by crystallisation.

A considerable amount of sodium nitrate is also produced in Egypt. For one company in 1913 the output was 4740 metric tons, but the total output is not known definitely. In India potassium nitrate has been produced from very early times, but the trade has always been subject to great fluctuations. It attained its highest values during the American Civil War, for then India had practically a monopoly of the supplies of saltpetre needed for explosives. At that time the average annual exports were 30,000 tons, but the development of the Chilean industry caused the Indian trade to decline, until in the years just before the war the exports were only 13,000 or 14,000 tons per annum. The war period again stimulated the trade, and in 1918 the output was 25,145 metric tons. The potassium nitrate is found in the soils of old villages, mixed with nitrates of calcium and magnesium and with sodium chloride. The process of extraction consists in dissolving out the mixed salts from the surface soil, roughly separating the sodium chloride and the potassium nitrate, and then purifying the nitrate.

Nitrogen compounds are also obtained as by-products in a large number of industries. In dealing with animal, vegetable, and fish products, organic ammoniates are obtained, and these are left as such for use in agriculture, while from sources such as coal distillations, bone carbonisation, oil-shale distillation, and blast-furnace operations, nitrogen is recovered as ammonia and ammonium salts—chiefly ammonium sulphate, which is available in all capacities. The organic nitrogen recovered in these various by-product connections probably constitutes about 40 to 50 per cent. of the total supply, but this nitrogen has to compete for its market against the supplies of nitrates from natural sources and against those of synthetic nitrates, *i.e.* those obtained from combined atmospheric nitrogen.

As early as 1781 Cavendish discovered that a nitric reaction was shown by water obtained by burning hydrogen in excess of air, and since his time very many chemists have studied the problem. In 1900 two Americans erected an experimental plant at Niagara for producing nitric acid from atmospheric nitrogen by means of a very high electric current, but this soon proved unremunerative and was abandoned. The luminous arc process for fixing atmospheric nitrogen was the first to be established commercially. In this process a dilute gaseous mixture of nitric oxides with air is obtained from the oxygen and nitrogen in the air; the nitric oxide is converted into nitric dioxide, and then absorbed in water to form nitric acid. It was started in Norway in 1903, and, owing to the cheap horse-power there available, and to the fact that the raw materials cost nothing and are always at hand, nitric acid can be produced there by the arc process at less cost than by any other commercial process. Efforts to introduce this process outside Norway have been unsatisfactory, partly because of its uneconomical use of power, and partly because of the difficulty in the subsequent handling of the end-product, a 30–35 per cent. acid against a 50–55 per cent. acid obtained by other processes.

The Haber process for ammonia synthesis was brought to a successful commercial stage in Germany in 1913, when the plant capacity was 30,000 tons of ammonium sulphate. In 1918 the output by this process was 1,060,000 tons of ammonium sulphate. The process consists of forming ammonia by the direct combination, under the influence of a catalyser, of nitrogen from the air and hydrogen obtained from water. The production and purification of the hydrogen involve one of the chief items of cost in this process, but in spite of this the Haber is the cheapest process for the production of synthetic ammonia, and has the lowest power requirement of any of the nitrogen fixation methods.

In 1906 the calcium cyanamide process was successfully installed in Italy, and before the war it was also installed in Germany, Norway, France, Switzerland, the United States, Austria, Japan, and Sweden. The method is a complicated one, and involves a large number of stages, but it has developed extensively, because it requires only about one-fifth the horse-power per ton of fixed nitrogen per year that is required by the arc process, though five times that required by the Haber process.

Several other methods for nitrogen fixation are being experimented with, but they are not yet developed commercially. Mr. Fischer, after a full discussion, concludes that the result is that Germany can produce nitrates at one-half the cost in the United States, and, consequently, the German farmer can be supplied with fertilisers at one-half the cost to the American farmer. This is an enormous advantage to Germany, and if Germany succeeds in monopolising this industry —which she is in a position to do, barring internal disorders—she can either export nitrates at a price which will enable her to supply her farmers with fertilisers at a negligible cost, or undercut the price of nitrogenous products so that it will be unprofitable for the Chilean mines to continue working. Germany would thus in time indirectly control the world's production of explosives. Mr. Fischer therefore urges on the American people the importance of constructing plants for producing synthetic nitrates, by which means "our security would be vastly increased, the burden of obligation carried by our fleet would be greatly reduced, and its functional, effective value doubled."

Industrial Research Associations.

VIII.—The British Photographic Research Association.

By Dr. T. Slater Price.

The British Photographic Research Association was the first research association to be formed under the scheme of the Privy Council for the promotion of industrial and scientific research. Early in 1918 the manufacturers of photographic materials and apparatus decided to avail themselves of the scheme, and the research association was incorporated on May 15, 1918. The president of the association is Sir J. J. Thomson, and the chairman Mr. Gerald M. Bishop, of Messrs. Marion and Co., Ltd. The council of the association consists of representatives from the various sections of the industry, together with several well-known men of science, who are also represented on the list of vice-presidents. The first director of research was Dr. R. E. Slade, and laboratory accommodation was obtained in the chemical department of University College, Gower Street, where work was carried on until the end of September, 1920. Owing to the large influx of students in the present session, however, it was necessary to vacate the laboratories at University College, and at the beginning of October the research association was transferred to the Institute of Chemistry, 30 Russell Square, W.C.1, where various rooms have been specially fitted and equipped for research work. In March, 1920, Dr. Slade resigned his position as director of research, and the present writer was appointed his successor, taking up his duties in the middle of September last.

As stated in the programme of research which has been issued, the object of the association is to carry out research in photography, photochemistry, and other related subjects with a view to the general increase of knowledge of the subjects, to improve methods of manufacturing photographic materials, and to discover new photographic processes. It is recognised that manufacturers will always insist on determining for themselves the lines on which their businesses shall develop, and the true aim of the association should be, by the proper application of scientific methods, to obtain knowledge which will be of the widest application to the industry, and which it will be left to each manufacturer to apply in his own way to the development of his business.

It is recognised not only that applied research should be undertaken in connection with the improvement of products now being manufactured and of methods of manufacture, but also that pure research on the scientific basis of photography and on related subjects such as colloidal chemistry and photochemistry should be carried out, although there may not necessarily be any immediate application of the results to manufacturing processes. Pure research of this nature has already been done, as is instanced by the following list of published papers :—

Contrast and Exposure in X-ray Photographs through Metals, by R. E. Slade (Trans. Faraday Soc., 1919, vol. xv., p. 52). A discussion of the effects of various qualities of X-rays on the photographic plate, and the possibilities of using plates to detect very small flaws in the examination of large bodies of metal.

The Fundamental Law for the True Photographic Rendering of Contrast, by A. W. Porter and R. E. Slade (*Phil. Mag.*, 1919, vol. xxxviii., p. 187). A consideration of the conditions which must be fulfilled by photographic materials in order that a true reproduction of the tone-values of an object may be obtained in the final print.

The Emulsion for a Process Plate, by R. E. Slade and G. I. Higson (*Phot. Journ.*, 1919, vol. lix., p. 260). A description of the type of silver halide emulsion most suitable for a process plate giving great contrast.

Photomicrography in Photographic Research, by G. I. Higson (*Phot. Journ.*, 1920, vol. lx., p. 140). A description of a special type of photomicrographic apparatus specially designed for high-power work in the examination of emulsions.

The Photometric Constant, by G. I. Higson (*Phot. Journ.*, 1920, vol. lx., p. 161). A mathematical discussion of the relation between the photometric density and the quantity of silver deposit in a photographic plate.

A New Method of Spectrophotometry in the Visible and Ultra-violet and the Absorption of Light by Silver Bromide, by R. E. Slade and F. C. Toy (Proc. Roy. Soc., 1920, A, vol. xcvii., p. 181). A description of a new method free from certain sources of error, by means of which the extinction curve for silver bromide was determined throughout the visible and ultra-violet regions of the spectrum.

Some Problems in High-power Photomicrography, by R. E. Slade and G. I. Higson (Trans. Faraday Soc., 1920, vol. xvi., p. 101). A contribution to the general discussion on the microscope held by the Faraday Society.

A Simple Non-intermittent Exposure Machine, by G. I. Higson (*Phot. Journ.*, 1920, vol. lx., p. 235). A description of a novel and simple form of exposure machine with which a plate can be exposed to a light of constant intensity for a series of known times.

Photochemical Investigations of the Photographic Plate, by R. E. Slade and G. I. Higson (Proc. Roy. Soc., 1920, A, vol. xcviii., p. 154). An experimental investigation of the photochemical behaviour of the silver bromide grain, from which an expression connecting intensity, time of exposure, and effect on the grains can be deduced.

The Absorption of Light by the Goldberg Wedge, by F. C. Toy and J. G. Ghosh (*Phil. Mag.*, 1920, vol. xl., p. 775). An investigation of the neutrality of the Goldberg wedge, showing that this neutrality is confined to the visible portion of the spectrum.

Before the war the manufacturers of cameras made use of wood which had been stained black right through. It was obtained from Germany, and was not procurable in England after the outbreak of war. The research association undertook the investigation of such a staining process, with successful results, as may be seen by reference to English Patent No. 17,638/19. It now remains for the manufacturers to develop the process on a commercial scale. At the same time, a quick process for staining wood brown right through was devised.

The methods of making sensitive emulsions for coating on plates and papers have been brought to a high standard of excellence by the various English manufacturers. To a large extent, however, the methods used are the result of experience, of trial and error; different manufacturers obtain similar results by widely different methods. An inexhaustible field of work is open for the definite correlation of the physical and chemical properties of the materials used with the methods employed and the sensitiveness and other characteristics of the emulsion obtained. A commencement is being made on this line of work, the technical heads of the various firms putting their experience and knowledge at the disposal of the research association. Any useful results obtained in the research laboratories will then be tested on a large scale in the works, since it is more than usually difficult in emulsion-making to pass successfully from the laboratory to the works scale.

There is also need for improved methods of laboratory testing of the raw materials of the industry so as to establish greater confidence between buyer and seller, particularly in regard to gelatine, bromides, raw and baryta-coated papers, and packing materials.

The literature of photography is very scattered, and, doubtless owing partly to the subtle nature of many photographic phenomena, important details have often been overlooked, with the consequence that the results of different workers often appear very contradictory. One of the objects of the research association is to collect and summarise this literature so that it may be placed at the disposal of the members of the association. Progress is being made in this direction, but it is necessarily slow.

Obituary.

SIR LAZARUS FLETCHER, F.R.S.

BY the death of Sir Lazarus Fletcher, mineralogy loses one who for a long period was recognised as the leading exponent of that branch of science in this country. Born at Salford on March 3, 1854, Sir Lazarus died suddenly from heart failure at Grange-over-Sands on January 6 in the sixty-seventh year of his age. He was educated at the Manchester Grammar School, and afterwards at Balliol College, Oxford, where he held the Brackenbury science scholarship. He obtained first-class honours in mathematical moderations and in the final schools of mathematics and natural science. From 1875–77 he served as demonstrator in physics under Prof. Clifton at the Clarendon Laboratory, and for the next two years he held the Millard lectureship in physics at Trinity College, Oxford. From 1877–80 he was a fellow of University College, Oxford. While at the Clarendon Laboratory he became interested in the study of crystals, and, as the result, when, in 1878, Mr. W. J. Lewis (now professor of mineralogy at Cambridge) retired, owing to ill-health, from the assistantship which he held in the mineral department of the British Museum, Prof. Story-Maskelyne, who was then keeper of minerals, induced Fletcher to apply for the post. He obtained it, and only two years later succeeded to the keepership.

Almost immediately on taking charge of the department Fletcher was called upon to supervise the removal of the mineral collection from Bloomsbury to its present home at South Kensington. What this meant may best be told in his own words[1]: "Some idea of the nature of this task may be formed if it be pointed out that the cabinets of the table-cases at Bloomsbury were to be made use of in the new gallery, but that the glazed table-tops were to be left behind; that the new table-tops were then lying on the gallery floor at South Kensington, and had as yet no supports; that differences of illumination of the old and the new galleries, and differences of construction of the cabinets, made it necessary that the relative positions of the cabinets in the gallery at South Kensington should be completely different from the relative positions in the gallery at Bloomsbury; that every cabinet had for some time to be turned upside down during the process of being fitted to the new floor; that many of them had to be cut in two because of the interference of the structural columns of the gallery, and new mahogany ends had afterwards to be made and fitted to them. Such a series of operations involves great practical difficulties when the specimens to be removed and arranged are numerous, fragile, and require to be cautiously handled, or are small, portable, and of great intrinsic value, and must be kept under lock and key." Once the collections were put in order, Fletcher devoted his attention to selecting and setting out series of specimens to facilitate the study of meteorites, minerals, and rocks respectively, and prepared a corresponding set of elementary hand books which are models of clear and simple exposition of not readily understood subjects. In 1909 he succeeded to the directorship of the Natural History Museum, which had been vacated by Sir E. Ray Lankester two years before. Unfortunately, a severe illness a year or so before his appointment left him with a crippled constitution, and soon he appeared to lose that keenness and energy which had previously characterised him; and by the time, in 1919, he reached the full age for retirement he was a tired man.

Many honours were conferred upon Fletcher by scientific institutions and universities at home and abroad. He was elected a fellow of the Royal Society in 1889, and was a vice-president from 1910–12, and in 1912 he was awarded by the Geological Society the coveted Wollaston medal. In 1894 he was president of the Geological Section of the British Association at its meeting at Oxford. The Mineralogical Society owes him a special debt of thanks, for to him its success and prosperity are largely due; he was its president from 1885–88, and from the latter year until 1909 served as its secretary. To commemorate such long service mineralogists and other friends subscribed and presented him with his portrait. He was knighted in 1916.

Despite the calls of his official duties, Fletcher found time to devote himself to scientific research, mainly to the subject of meteorites, to their history and constitution and the problems presented in the analysis of these bodies, but also to certain isolated, yet exceedingly important, questions in crystallography. Until the publication of his Optical Indicatrix in 1892 the whole theory of the optical characters of biaxial crystals as presented in the text-books was based on faulty and contradictory premises. With characteristic industry he went back to the original source, and read all Fresnel's early papers on this subject, and found that the latter had followed a perfectly logical and convincing course in his approach to his theory, and had departed from it only when desirous of providing a physical basis for his fundamental hypothesis. Fletcher, in his treatise, shows that the wave-surface for a biaxial crystal can in the manner originally put forward by Fresnel be derived from a simple extension of Huyghens's theorem, and his method is followed in all modern text-books on crystallography and the optical characters of crystals. He was gifted with considerable manipulative skill in delicate experimental work, the best example of which was his remarkable investigation of the morphological and chemical properties of the crystallised form of native zirconia, which was first discovered by him, and to which he gave the name "baddeleyite"; he obtained the whole of the requisite information from a study of a single, ill-developed crystal, which was all the material at his disposal, the analysis being made on the tiny fragments that had adhered to the wax of the crystal-holder.

Sir Lazarus Fletcher was twice married, first to Miss Agnes Ward Holme, who died in 1915, leaving a daughter, and afterwards, in 1916, to her sister, Edith; his widow and daughter survive him. A man of studious habit, of quiet geniality, and gifted with a subtle North-country humour, he will be mourned by a large circle of friends.

The death is announced, at the age of seventy-seven, of Mr. Thomas A. O'Donohoe, known by his work in microscopy and bacteriology. Mr. O'Donohoe made investigations on the tubercle bacillus and on the anatomy, habits, and metamorphosis of the house-fly, and at the time of his death was studying the winter stages of this insect. He was an authority on the optics of the microscope and photographic camera, and did much work on the mounting of objects for microscopic research.

[1] "History of the Collections in the Natural History Departments of the British Museum" (1904), vol. i., p. 349.

MANY men of science in this country will learn with great regret that PROF. H. A. BUMSTEAD, professor of physics at Yale University, and president of the National Research Council of the United States, died suddenly at Washington on January 1. Prof. Bumstead was for some time in London during the war, and was the head of the American organisation for keeping touch between the two countries in matters concerning the application of science to war.

Notes.

WE publish in our correspondence columns this week a translation of a letter from Prof. F. M. Exner, director of the Central Meteorological and Geodynamic Institute at Vienna, and Prof. J. Hann, the former director, appealing for financial aid to enable the institute to carry on the valuable work it has done for meteorology for the past seventy years, and to continue its publications. Already, both in Great Britain and in the United States, funds have been provided for meeting the personal needs of meteorologists in Vienna who were without the necessaries of life, but meteorologists are not, as a rule, wealthy men, and they cannot do much more than they have done. Other scientific workers have probably approached much the same limit of their capacity to help. While, therefore, we commend the appeal to our readers, we think it would be difficult for private benefactors to provide the means for carrying on the work of the institute. A much more promising course to urge is that some part of the credits made to Austria by England and France should be ear-marked for the maintenance of essential scientific services. We suggest that the Royal Society or the Royal Meteorological Society should take steps with the object of securing support of this kind for the Meteorological Institute at Vienna.

MR. C. E. FAGAN is expected to retire from the British Museum (Natural History) in the spring of this year. He entered the service of the Trustees in 1873, and became assistant secretary in 1889. He received the title of secretary in 1919, in recognition of the conspicuous value of his services. It is safe to say that Mr. Fagan has done more than any other living man in developing the importance of the museum as a centre of scientific activity. His long experience, his grasp of affairs, and his unfailing capacity for forming a correct judgment have made his co-operation and advice invaluable to the Trustees and to his colleagues. His administrative ability has been of the greatest service to successive directors, whom he has assisted in innumerable ways, while during more than one period of interregnum he has succeeded in maintaining the efficiency of the museum at a high level. Although not himself an investigator, Mr. Fagan has taken a keen interest in many aspects of natural history, and has been quick to appreciate the importance of an opening, whether the chance of securing a valuable collection or the opportunity of encouraging an expedition to some distant country. He has been closely associated with such societies as the British Ornithologists' Union and the Royal Geographical Society, the interests of which are connected with those of the Natural History Museum. Opportunities of making the museum practically useful have a special appeal for him, and he has taken great interest in exhibits of economic importance. From the first he has been a strong supporter of the close connection which happily exists between the museum and the Imperial Bureau of Entomology. Mr. Fagan has rendered exceptional services to science by single-minded devotion to his ideal of increasing and developing the scientific importance of the museum. The fact that he is suffering from a severe illness at the time which he had hoped to devote to putting the finishing touches to his long period of successful service will command the ready sympathy of his many friends.

WE hope that the Victor Horsley Memorial Fund will be well supported. The *Times* publishes a strong appeal for it, signed by the president of the Royal College of Surgeons, the professor of physiology in the University of Edinburgh, and others. "If only each patient whose life he saved," they say, "were to contribute to our fund according to their means, we should have all the money that we require, and more." Contributions may be sent to Sir Frederick Mott, 25 Nottingham Place, W.1, or to Dr. Howard Tooth, 34 Harley Street, W.1. The plan is for a scholarship or a lectureship. We all remember the coming of the news of Horsley's death from heat-stroke in Mesopotamia in July, 1916. Some of us, more fortunate, also remember the wonder of his threefold work in 1884–90: his advancement of the physiology and surgery of the central nervous system, his studies of the thyroid gland and of myxœdema, and his uphill fight, as Pasteur's representative, for the stamping-out of rabies. After 1890 Horsley was for a quarter of a century incessantly teaching, incessantly learning. Alike in hospital practice and in private practice, he set himself to Guy de Chauliac's ideal of a surgeon: "Bold when sure, cautious in danger, kind to the sick, friendly with fellow-workers, constant in duty, not greedy of gain." Moreover, he worked hard, no man harder, for the betterment of his profession, for its greater efficiency in the all-round service of national health, and for the protection of its poorer members against exploitation and the insolence of office. Later he was in the forefront of the fight against drink, the fight for the welfare of children, and the fight for votes for women. He was ever a fighter, and he offended by his vehemence, his intolerance. But those who were altogether opposed to him in politics are none the less thankful for his magnificent work in physiology and surgery; it went over all the civilised world, and we are bound in honour to commemorate his name.

WE refer elsewhere to the annual meeting of the Mathematical Association and the presidential address by Canon J. M. Wilson. The assistance given by

NATURE to the movement for the improvement of geometrical teaching referred to in the address is not without interest to our readers. Prof. Hirst (in his lectures at University College, London, and elsewhere) and a young master at Rugby, the present Canon Wilson (in a paper read before the London Mathematical Society, printed in the *Educational Times* for September, 1868), were among the first to raise the note of dissatisfaction. Mr. R. Tucker, of University College School, was the first to broach the subject in our columns (NATURE, March 24, 1870, vol. i., p. 534), while the next effective contribution was from Mr. Rawdon Levett, of King Edward's School, Birmingham, who (May 26, 1870, vol. ii., p. 64) raised the fiery cross and called for an Anti-Euclid Society. Mr. Wormell then suggested that contributions to the expenses of propaganda should be sent to Mr. Levett. The result was the notice of a forthcoming conference (NATURE, December 29, 1870, vol. iii., p. 169). At the first meeting Messrs. Hirst and Wilson secured the substitution of "improvement" for "reform" in the title of the New Association for the Improvement of Geometrical Teaching, and it was Canon Wilson who suggested that the association would best justify its existence by preparing a syllabus. At the meeting of 1872 he proposed the appointment of a sub-committee to draw up a detailed syllabus of geometry to be submitted to the highest mathematical authorities and examining bodies. The next year he moved that the adopted syllabus should be sent to the British Association for its comments. In 1874 he moved that the five schemes of proportion mentioned in the report of the committee be examined by all the members and their opinions be invited. After that year his attendance became less regular, but it will be seen that he took the foremost place in the actual work of getting out the syllabus. It must be a source of satisfaction to Canon Wilson to find the bantling at the birth of which he was present fifty years ago now in its turn the parent of branches in these islands and the Colonies, and, *post tot annos*, sending forth once more through his lips its message of achievement. Of the venerable canon, who is now eighty-five, it may almost be said that his eye is not dim nor his natural force abated.

THE KING has signified his intention of conferring the honour of knighthood on Dr. Maurice Craig, Consulting Neurologist to the Ministry of Pensions, and Dr. P. Horton-Smith Hartley, senior physician at the Hospital for Consumption and Diseases of the Chest, Brompton.

PROF. E. W. SCRIPTURE, who contributes to this issue the first of two articles on "The Nature of Vowel Sounds," was formerly professor of experimental psychology in Yale University, but is now resident in London, where he has been for some years engaged on studying records of speech in epilepsy, general paralysis, and other nervous diseases. Prof. Scripture has lately returned from Germany, where he has been lecturing on experimental phonetics applied to the study of English. These were the first lectures delivered in Germany since the war by a professor from a former enemy country.

ON Tuesday next, January 18, at 3 o'clock, Sir G. P. Lenox-Conyngham will give the first of two lectures at the Royal Institution on "The Progress of Geodesy in India"; and on Thursday, January 20, Dr. Arthur Harden will begin a course of two lectures on biochemistry (vitamines). The Friday evening discourse on January 28 will be delivered by Sir James Dewar on "Cloudland Studies."

THE council of the Geological Society has this year made the following awards:—Wollaston medal (in duplicate), Dr. John Horne and Dr. B. N. Peach; Murchison medal, Mr. E. S. Cobbold; Lyell medal, Dr. E. de Margerie, director of the Geological Survey of Alsace-Lorraine; Bigsby medal, Dr. L. L. Fermor, Geological Survey of India; Wollaston fund, Dr. T. O. Bosworth; Murchison fund, Dr. Albert Gilligan; and Lyell fund, Prof. H. L. Hawkins, Reading University College, and Mr. C. E. N. Bromehead, H.M. Geological Survey.

THE annual meeting of the Iron and Steel Institute will be held on Thursday and Friday, May 5 and 6, at the Institution of Civil Engineers, Great George Street, London, S.W.1. Dr. J. E. Stead, president, will preside. In March the council will be prepared to consider applications for grants from the Carnegie Fund in aid of research work of such value as may appear expedient, but usually of the value of 100*l.* in any one year. The awards are made irrespective of sex or nationality. Special forms, on which candidates should apply before the end of February, can be obtained from the secretary of the institute. The research work must be on some subject of practical importance relating to the metallurgy of iron and steel and allied subjects. The results of research work must be communicated to the institute in the form of a report.

AT a general meeting of the Royal Meteorological Society to be held in the rooms of the Royal Astronomical Society, Burlington House, at 8 p.m., on January 19, a proposal will be brought forward for the incorporation of the Scottish Meteorological Society with the Royal Meteorological Society. The Scottish society has done useful work in the advancement of meteorology, particularly the meteorology of North Britain, since its foundation in 1855. It was closely connected with the work of the high-level observatory maintained on the summit of Ben Nevis for many years. It is felt that the time has now come when a fusion of the two bodies which represent the science north and south of the Border will be to the interest of meteorology as a whole and advantageous to the fellows of both societies. At 8.30 p.m., after the termination of the business meeting, Mr. R. H. Hooker, president of the Royal Meteorological Society, will deliver an address on "Forecasting the Crops from the Weather." Any workers interested in this subject from either the meteorological or the agricultural side are invited to the lecture.

THE Board of Trade has appointed Sir R. T. Glazebrook to be Chief Gas Examiner under the Gas Regulation Act, 1920, and Mr. C. V. Boys, Dr. J. S. Haldane, and Mr. W. J. A. Butterfield to be Gas

Referees. The Board has also appointed Mr. H. C. Honey to be Director of Gas Administration in the Power Transport and Economic Department, Board of Trade Offices, Great George Street, S.W.1. In pursuance of the provisions of section 2 (4) of the Act, the Board has appointed Sir William Pearce (chairman), Dr. T. Carnwath, Mr. W. D. Gibb, and Dr. T. Gray to be a Committee to inquire whether it is necessary or desirable to prescribe any limitation of the proportion of carbon monoxide which may be supplied in gas used for domestic purposes. It has also appointed Mr. J. H. Gray (chairman), Mr. W. J. A. Butterfield, and Dr. C. H. Lander to be a Committee to inquire whether it is necessary or desirable to prescribe any limitations of the proportions of incombustible constituents which may be supplied in gas. Communications should be addressed to the Secretary to each of these Committees at the Power Transport and Economic Department, Board of Trade, Great George Street, S.W.1.

THE Air Ministry announces that the Cabinet has approved, subject to Parliamentary sanction, the grant of a sum for the direct assistance of civil aviation. During the financial year 1921–22 payments under this grant will be limited to a maximum sum of 60,000*l*., and will be made to British companies operating on approved aerial routes. The routes at present approved are London to Paris, London to Brussels, and London to Amsterdam. Extensions to these routes and additional routes, such as England–Scandinavia, on which the possibilities of a service employing flying boats or amphibian machines or a mixed service of sea and land aircraft can be demonstrated, may be approved from time to time if satisfactory proposals are received by the Air Council. The maximum time allowed for journeys between London and Paris, between London and Brussels, and between London and Amsterdam will be four hours from aerodrome to aerodrome (or such other time limit as may be determined later by the Air Council). Any British company intending to run on the routes and notifying the Air Council of this intention will become an "approved" organisation by fulfilling the conditions laid down. Such notification should be addressed to the Secretary (C.G.C.A.), Air Ministry, Kingsway, W.C.2, to whom requests for further particulars in respect of the grant should be addressed.

THE KING, on the recommendation of the Home Secretary, has approved the appointment of a Royal Commission to inquire into the existing provision for: (1) The avoidance of loss from fire, including the regulations dealing with the construction of buildings, dangerous processes, and fire risks generally, the arrangements for inquiry and research and for furnishing information and advice to public authorities and others on matters relating to fire prevention; and (2) the extinction of outbreaks of fire, including the control, maintenance, organisation, equipment, and training of fire brigades in Great Britain; and to report whether any, and if so what, changes are necessary, whether by statutory provision or otherwise, in order to secure the best possible protection of life and property against risks from fire, due regard being paid to considerations of economy as well as of efficiency. The Commission will be composed as follows:—The Hon. Sir Perceval M. Laurence (chairman), Mr. J. T. Burns, Sir Vincent H. P. Caillard, Mr. A. L. Dixon, Sir Maurice Fitzmaurice, Capt. V. L. Henderson, Sir Joseph E. Petavel, Mr. H. Peters, Lt.-Comdr. Sir Sampson Sladen, Mr. H. Stilgoe, and Lt.-Col. G. Symonds. In addition, there will be representatives of the County Councils' Association, of the Association of Municipal Corporations, and of the Fire Offices' Committee. The names of these representatives will be announced later. The secretary is Mr. J. C. MacIver, of the Home Office. Any communications on the subject should be addressed to him at 5 Old Palace Yard, S.W.1.

UNTIL its work is completed and the materials are collected, published, and exhibited, it is somewhat premature to forecast the results of the Mackie Expedition to Central Africa under the conduct of the Rev. John Roscoe. It is clear from letters received that much success has been achieved among the Bunyoro tribe, which occupies the country to the east of Lake Albert in the Uganda Protectorate. This information has been summarised in an important paper by Sir J. G. Frazer, published in the December issue of *Man*.

MR. W. W. ROUSE BALL has reprinted through Messrs. Heffer and Sons, Cambridge, the interesting lecture which he delivered last spring at the Royal Institution on string figures, which we noticed at the time in these columns. He has added full directions for the construction of several easy typical designs, arranged roughly in order of difficulty, and, for those who wish to go further, lists of additional patterns and references. This fascinating art can be practised with the simple aid of a piece of good string some 7 ft. long.

THE Welsh Department of the Board of Education has issued, under the title of "Scheme for the Collection of Rural Lore in Wales," a pamphlet containing a series of rules and suggestions for secondary schools and colleges. The scheme has been financed by members of the Honourable Society of Cymmrodorion with the object of preparing a kind of Welsh Domesday Book, the material of which is to be collected by teachers and pupils. One part of the scheme is the collection of all Welsh place-names from the ordinary Survey maps and other sources. Rural industries, survivals of old or curious customs and crafts, peculiar words, local proverbs, primitive agricultural implements, marks on sheep or ponies, notice of places where old pottery and the like have been discovered—in fact, all kinds of information on rural and industrial life are solicited. The scheme is well conceived and the instructions are helpful. Educational authorities in other parts of these islands may well consider how far the Welsh scheme can be adapted to local conditions.

THE Gem Dry Plate Co., Cricklewood, N.W., has forwarded to us a pamphlet on photomicrography. A simple account is given of the process, which includes a description of apparatus, illumination, focussing, exposure, the use of light-filters, printing, and development. The pamphlet is illustrated with eight excellent plates showing reproductions of photomicrographs of diatoms, foraminifera, sections of animal and plant tissues, anthers and pollen, etc.

IN *Archives of Radiology and Electrotherapy* for November last (No. 244) Mr. H. A. Colwell continues his sketch of the history of electrotherapy. An account is given of the introduction and use of the galvanocautery, electrolysis, and influence machines, with illustrations of the first apparatus employed. It is interesting to see that an "electrical room" was started at Guy's Hospital in 1836, and various forms of electrical treatment were investigated by Addison, Golding-Bird, and Gull among others.

THE Tidal Investigations and Results of the Canadian Arctic Expedition, 1913–18, are issued as vol. x., part C, of the report of that expedition. Dr. W. B. Dawson notes that observations were made for varying lengths of time at ten stations on the south and east of the Beaufort Sea. The low temperatures and the consequent hardening of the oil in the clockwork of the registering tide-gauges presented a difficulty, which, however, was largely overcome by installing the instruments in snow-houses. The temperature of snow-houses can be kept at 40° to 50° F. by the use of lamps without the walls thawing. The range of the tide on the open shores was usually less than 1 ft., and seldom as much as 1½ ft. At the head of Amundsen Gulf it occasionally exceeded 2 ft. This small range is too slight to have any direct effect on navigation, but sufficient to move grounded ice. From the few data available it appears that the tide enters the Beaufort Sea from the north and moves southward and westward. Dr. Dawson recommends the establishment of some permanent tidal station for reference, and suggests the suitability of Herschel Island, which is one of the few localities in the region with a settled white population.

THE relation of surface visibility of the atmosphere to suspended impurity is dealt with in the *Meteorological Magazine* for December by Dr. J. S. Owens. In commenting on the difficulty of dealing with the whole subject of visibility experimentally, and especially with reference to the visibility of lights, allusion is made to the scattering of light by the small suspended particles in the air. Allusion is also made to the important part that the perception of colour plays in visibility, and it is stated that the sensitiveness of the eye for blue-greens is greater than for reds when the light is fading. Mr. N. K. Johnson contributes a communication on the visibility of pilot-balloons. He gives the results of an attempt made at Shoeburyness to determine which colour is most suitable for pilot-balloons, and especially for long-distance work. When the sun is shining on a balloon its visibility depends on its reflective power; without the sunshine you have to depend on the opacity of the balloon. The results are summarised as follows:—(1) Against a background of continuous dense white cloud either red or blue should be used. (2) If the sky contains slight cirrus or haze red is the correct colour to employ. (3) On occasions on which the sky is cloudless and of a deep blue colour a white balloon should be selected. The magazine shows that the total rainfall in November varied greatly in different parts of the British Isles. The general amounts were:—For England and Wales, 49 per cent. of the average; Scotland, 106 per cent.; and Ireland, 110 per cent.

WE have received from the firm of Messrs. Adam Hilger, Ltd., pamphlets describing their most recent spectrographs. Instruments with quartz prisms and lenses can be supplied ready for photographs to be taken to give the whole spectrum from 210 $\mu\mu$ to 800 $\mu\mu$. In some cases an accurate scale of wave-lengths is mounted internally so that a contact print of the scale can be obtained on the same plate as the photograph of the spectrum. Concave-grating spectrographs with the mounting designed by Mr. A. Eagle are recommended, as this form is found to possess many advantages in comparison with the classical Rowland mounting. The apparatus occupies very little space and possesses great rigidity. For the investigation of the Schumann and Lyman regions of the spectrum, which may yield most important theoretical results, the same type of mounting is used in a vacuum spectrograph. By the use of two slits the whole spectrum from 210 $\mu\mu$ to 50 $\mu\mu$ may be obtained with one setting of the grating. This is the instrument which has been employed by Prof. McLennan and his fellow-workers. Messrs. Hilger also construct an X-ray spectrometer as designed for Sir W. H. Bragg on the principle of Dershem.

THE problem of the high-frequency resistance and inductance of parallel wires is one that has been studied very carefully by many physicists, including Maxwell, Kelvin, Rayleigh, and Heaviside. The problem, however, which they considered was the symmetrical case of a cylindrical conductor when the return current was so far away that its magnetic effects on the distribution of the current in the cylinder could be neglected. A notable advance in the theory has recently been made by Mr. Harvey L. Curtis in a paper published by the Bureau of Standards, Washington (No. 374). Mr. Curtis has developed a new mathematical method by means of which he easily obtains the ordinary solutions applicable to a concentric main, and, in addition, obtains solutions for two parallel cylindrical mains at given distances apart. His solutions have been verified experimentally by the Bureau of Standards. It was found, for instance, that when an alternating current of 3000 frequency was sent through a circuit consisting of two parallel wires 0·651 cm. in diameter and 0·039 cm. apart the ratio of the alternating-current resistance to the direct-current resistance was 2·4. If the ordinary formulæ had been applied the ratio would have only been about 1·5. Similarly, it is shown both by theory and by the experimental results obtained that the irregular distribution of the current over the cross-section of the wire due to the proximity of the high-frequency return current very appreciably diminishes the coefficient of self-induction of the circuit.

THE "Index Medicus: A Classified Record of the Current Medical Literature of the World" (Washington: Carnegie Institution of Washington), which has hitherto been a monthly publication, will in future be issued at quarterly intervals. It will give the full titles of books, pamphlets, theses, original articles in journals, and transactions of medical and scientific societies. In the case of contributions printed in the lesser-known languages, their titles will be rendered into English. Each number will contain a general table of contents, and as soon as possible after the completion of each volume an "Annual Index of Authors" will be issued. Subscriptions to the work should be sent direct to the Carnegie Institution of Washington, Washington, D.C., U.S.A.

A USEFUL catalogue (No. 86) of second-hand books and journals relating to zoological subjects has just been received from Messrs. Dulau and Co., Ltd., 34 Margaret Street, W.1. It contains upwards of 1100 titles. Among the works listed we notice a first edition of "The Origin of Species," "The British Museum Catalogue of Birds" (27 vols.), Dresser's "A History of the Birds of Europe," and Reeve and Sowerby's "Conchologia Iconica"; also complete sets of the *Zoologist* and the *Entomologists' Record and Journal of Variation*. Copies of the catalogue can be obtained from the publishers.

THE latest catalogue (No. 361) of secondhand books and periodicals issued by Messrs. Bernard Quaritch, Ltd., 11 Grafton Street, W.1, is mainly of a general character, but lengthy sections devoted to botany, natural history, and Oriental literature make it worthy of the attention of readers of a scientific journal such as NATURE. As is usual with catalogues circulated by Messrs. Quaritch, many rare volumes are offered for sale.

Our Astronomical Column.

SKJELLERUP'S COMET.—It appears that this comet was first detected by Mr. C. J. Taylor at the Cape on December 8, Mr. Skjellerup finding it independently on December 11. It should, therefore, be called "Taylor-Skjellerup." Mr. R. L. Waterfield observed the comet at Hereford with a 4-in. refractor. His positions are not micrometrical, but eye-estimations from adjacent B.D. stars.:

G.M.T. d. h. m.	R.A. 1920·0 h. m. s.	N. Decl. 1920·0 ° ′
Dec. 31 12 0	10 16 38	16 22
Jan. 4 13 40	10 30 41	21 26

These agree within some 5′ with Mr. Wood's ephemeris, which is continued below (for Greenwich midnight):

	R.A. h. m. s.	N. Decl. ° ′	Log *r*	Log Δ
Jan. 16	11 0 41	33 24	0·1093	9·5783
20	11 7 17	36 22	0·1192	9·6095
24	11 12 3	38 51	0·1293	9·6406
28	11 15 11	40 56	0·1398	9·6715
Feb. 1	11 16 48	42 40	0·1506	9·7024
5	11 17 28	44 3	0·1615	9·7328
9	11 16 54	45 9	0·1726	9·7626
13	11 15 52	45 55	0·1837	9·7920
17	11 14 16	46 28	0·1948	9·8210
21	11 11 10	46 53	0·2055	9·8486

HISTORY OF THE CHRONOMETER.—Lt.-Comdr. R. T. Gould read a paper on this subject at the meeting of the Royal Geographical Society on December 13 which presents very vividly the tremendous revolution in navigation which this invention implied. He recalls Anson's disastrous voyage in 1741, when a mistake in the longitude caused such delay in making port that half the crew died of scurvy. After describing earlier abortive attempts, he proceeds to the famous prize of 20,000*l.* offered by the British Government in 1713, and won fifty years later by John Harrison, though he had undeniably earned the reward long before—a delay which reflected great discredit on the Government. The paper dwells on the inventive genius and constructive skill which Harrison continued to display; indeed, the performance of his various machines would be creditable at the present day. It is pointed out that his invention of the maintaining spring has never been superseded, and that the "remontoir" device for equalising the force on the escape-wheel, though no longer required on chronometers, has been introduced into the Riefler clock. Several anecdotes are given of Harrison's voyages, in which he frequently corrected the reckoning of the captain and officers; on one occasion he saved the ship from missing the Island of Madeira, to the great relief of the crew, who were short of beer.

Capt. Cook used a duplicate of Harrison's watch made by Kendall, and noted that "our longitudes can never be erroneous while we have so good a guide." The paper goes on to describe the work of Mudge, Le Roy, Berthoud, Arnold, and Earnshaw, and concludes by referring to the recent introduction of wireless telegraphy for time-distribution and direction-finding. The latter have effected a revolution in navigation almost as far-reaching as the invention of the chronometer.

THE PLANETESIMAL HYPOTHESIS.—This hypothesis, enunciated by Profs. Moulton and Chamberlin, has been favourably received by a number of writers, including Dr. Jeans in his recent work on cosmogony. The *Scientific Monthly* for last May contains an interesting *critique* on the theory by Prof. Reginald A. Daly, of Harvard University. Prof. Daly suggests some amendments to Chamberlin's views on the later stages in the earth's development. Chamberlin concluded that the earth's temperature was never very high, that its mass has slowly increased through the impact of planetesimal dust, and that oceans existed when it had only one-third of its present mass. Prof. Daly argues (1) that the matter composing the different planets is likely to be the same in the main, and (2) that the low density of the giant planets, combined with the phenomena observed on their surfaces, gives conclusive evidence of high temperature. He thinks that the earth was molten, if not gaseous, during its early history. An argument is also drawn from the moon; ascribing the numerous pits either to the fall of planetesimals or to volcanic action, there could scarcely fail to be considerable traces of similar formations on the earth unless the surface had been more or less molten. The remaining arguments are geological rather than astronomical, but one may be mentioned. The amount of salt in the ocean has led to an estimate of about 100,000,000 years for the period during which rivers have been flowing into it. This time-estimate would be much too small if we accepted Chamberlin's view of the early stage in the earth's history at which the oceans appeared.

The Physical and Optical Societies' Exhibition.

THE Physical and Optical Societies held their eleventh annual exhibition of scientific apparatus at South Kensington on January 5–6. There was a record attendance. The demonstrations and discourses were unusually attractive, a considerable number of visitors failing in their attempts to attend the discourses because of the overcrowded condition of the large lecture theatre. Sir W. H. Bragg gave an interesting lecture on "Sounds in Nature," and Mr. C. R. Darling showed by means of beautiful experiments some little-known surface-tension phenomena. On behalf of Prof. Archibald Barr, Dr. Morrison gave two addresses on the optophone, the instrument exhibited being the result of much patient research and development work by Messrs. Barr and Stroud. In the optophone a selenium bridge is exposed to successions of sets of light pulsations, which vary according to the forms of letters as these are passed over in traversing a line of printed type, each letter being indicated in a suitably connected telephone by a characteristic succession of single notes and chords. Printed letters are thus translated by the optophone into a sound alphabet which can be readily learned. Miss Mary Jameson, a blind girl, who attended the exhibition, read ordinary type at about ten words per minute, but when undisturbed her normal rate is about twenty-five words per minute. Many blind people were present.

Thermionic tubes and associated appliances were much in evidence. Prof. C. L. Fortescue and Dr. Bryan gave a very instructive demonstration of well-known circuit arrangements having all the parts exposed to view. The "heterodyne" or "beat" method of reception was demonstrated, and surprised many visitors because of the clearness of the beat tone. Another demonstration involving the use of valves was given by Messrs. Creed and Co. The apparatus which was shown received and recorded wireless messages at a working speed of 200 words per minute. The record is a punched slip of paper which by means of a printer is transcribed into Roman characters. The research laboratories of the General Electric Co. exhibited a number of valves with a new type of filament. This filament runs at a much lower temperature than the ordinary tungsten filament in the valves in general use at present. The increased strength resulting from lower temperature permits the use of finer filaments, the watts for heating these being only one-twentieth to one-fortieth of usual values. Thus it is possible to work a six-valve amplifier with a current consumption of half an ampere. Characteristic curves for these valves are very similar to those for existing types in use for wireless telegraphy.

In the optics section, Mr. Aldis exhibited a comparatively cheap but very perfect projector specially suited for projecting pond-life on the screen. With live specimens and a magnification of 300, the alimentary canal and internal organs of many specimens were shown with great clearness. There should be a good future for this projector for educational purposes. Messrs. Adam Hilger demonstrated a little-known application of the Fabry-Perot interferometer. A beam of white light is caused to traverse successively two plates of air, each with silvered faces, a system of fringes being obtained whenever the differences of path occasioned by each of the plates bear to each other a simple relation. If, then, a Fabry-Perot étalon is placed in series with a Fabry-Perot interferometer (the air plate in the étalon having a constant thickness and in the interferometer a variable thickness) a system of white-light bands is produced every time the distance between the silvered surfaces of the interferometer mirrors is either a multiple or sub-multiple of the distance between the plates of the étalon. Messrs. Hilger also demonstrated the Zeeman effect with a wave-length spectrometer and a Lummer-Gehrcke parallel plate. Messrs. R. W. Paul and F. Twyman demonstrated by the use of a Hilger-type interferometer the distribution of temperature around a hot body. The convection currents produced in air by electrically heated wires were beautifully shown.

Cathode-ray workers were interested in a 12,000-volt direct-current generator set shown in operation by Messrs. Evershed and Vignoles. A cathode-ray tube was placed in circuit and some of the possibilities of the method of investigating rapid changes of current were demonstrated.

The general display of all exhibits was particularly good, and great credit is due to the forty-eight instrument-making firms who exhibited for the excellence of their manufactures and for the care taken in arranging and explaining the purposes of their instruments. The finish of electrical instruments was of a very high order—much higher than last year, when many mass-production instruments were shown. In many cases it was gratifying to find that elegance of production was accompanied by a surprising robustness. As an example a simple galvanometer which appeared to be very good for schools was shown by Messrs. Gambrell Bros.; this has a self-locking device when it is not supported on a table, and, in consequence, it withstands extraordinary shocks in transit. The Cambridge and Paul Instrument Co. showed for the first time a modification of the Einthoven string galvanometer having six strings, the deflections of which are recorded on a moving band of photographic paper. This type of galvanometer was first used in sound-ranging in France, and was of great service during the war. An excellent amplifier for cable work (but it should have many other applications) was exhibited by Mr. H. W. Sullivan; the amplifier is a selenium-cell relay which is acted upon by a light beam from a galvanometer; a magnification of 10,000 was obtained. As usual, the Weston Instrument Co. had an excellent display of meters and parts of meters which only required inspection for one to understand why a Weston instrument is always trustworthy.

The optical section of the exhibition attracted increased attention because of the position of the optical trade as a key industry. The exhibits were certainly of a high class, and it is hoped that the efforts of the optical industry to establish itself firmly and to make its products inferior to none will receive support from the large number of visitors who admired the exhibits.

The Headmasters' Association.

THERE was a large muster at the annual meeting of the Association of Headmasters held in the Guildhall of the City of London on January 5. In his presidential address Mr. J. Talbot, headmaster of the Royal Grammar School, Newcastle-upon-Tyne, handled the new psychology in a sensible way. No one can question the results of psycho-analysis when applied to cases of neurosis. Many a soldier owes his recovery from shell-shock to the skill of men like Dr. Rivers, Prof. Elliot Smith, and Prof. Pear. But when a smatterer who has merely "read a book," or perhaps only listened to a lecture, begins to fumble round with the souls of healthy boys and girls it is a different matter, and teachers have no more right to experiment upon them in psychical matters than to make them the vile body for testing the properties of a patent nostrum. It may be true, as Dr. Crichton Miller has pointed out, that in nineteen out of twenty cases examined by the expert analysts the results point to faulty upbringing, either at home or at school, but it must be borne in mind that these twenty cases are not normal or typical in any way. When Dr. Mary Bell says there is no sin in a child helping itself to the contents of the mother's purse in order to buy presents for a teacher, this is simply playing fast and loose with the distinctions between right and wrong. Most homes and most schools will be well advised to stick to the Ten Commandments. If a child gets into serious trouble or is not healthily happy, there is a clear case for psychotherapy. Every schoolmaster of experience knows how helpful it may be in suggesting a hopeful method of treatment, for there were cases of shell-shock among children in the raid areas as well as among soldiers at the Front; and so long as boys are boys there will be cases of practical jokes, such as those which drove the poet Gray out of Peterhouse at Cambridge, and there will be cases of bullying, though these are now, happily, very rare. But for the normal treatment of normal school-life, the best training of the unconscious life, as Mr. Talbot said, is through the school games, school camps, scouting, and everything which enables a child's psychical faculties to function freely in relationship both to his teachers and to his fellows. Inasmuch as every child does not find itself in cricket, football, and hockey, it is well to widen the field of opportunity and to offer as large a variety as possible, so that no child in any school may live such a cowed life as Cowper lived at Westminster.

Prof. Percy Nunn's address on testing intelligence was as full of humour as of practical help and suggestion. Clearly the secondary school needs a certain *quantum suff.* of knowledge as well as of intelligence, and therefore written examination cannot be superseded in the selection of free-place holders. Both these forms of test bring out the child that has the power of rapid mental mobilisation, and the ablest child of all may very likely fail to shine. "Sentimental Tommy" failed to win his place on the list because he spent half the time available in thinking out the exact word which he wanted to fit his thought. Clearly the consummate artist in words is not a successful examinee. There is, in addition, the child who thinks below the surface of things, whom psychologists call the "introvert." He will take the question proposed and look at it in its bearings in relation to other deep thoughts which occupy his mind, and, as likely as not, he will want to reformulate the question altogether before he sets himself to answer it. As Prof. Nunn admitted, our present methods pass over this child; a Newton or a Coleridge would in all probability fail to win a scholarship. This is one point which calls for further work for the psychologists. Profs. Terman and Thorndyke have not yet faced this question, and the American Army had probably no use for a Coleridge or other poetic soul. This is only one of many questions which call for further research. It is important to be able to measure the vital force of the competitor, for a fund of vitality is quite as important for effectiveness in study, and, indeed, in life in general, as intelligence. It would be interesting to know how much deep breathing and cardiac strength have to do with that tenacity of purpose which so often wins through to high achievement, when mere brilliance of intellect fails because it is not backed by strength of perseverance.

The Mathematical Association.

AT a crowded annual meeting on January 4, Prof. A. S. Eddington gave an account of relativity. Those who wish to inform themselves on this subject will naturally go to Prof. Eddington's attractive book, "Space, Time, and Gravitation." No experiments to determine the motion or whereabouts of the æther had ever led to any but a negative result, as if one solving an equation should end up with the disappointing result 0=0 The view had therefore been put forward that there were certain compensating influences concealing the motion of the æther from detection. But Einstein had dared to take up the attitude of Betsey Prig in the matter of Mrs. Harris, "I don't believe there's no sich a person!" The party of Mrs. Harris, however, protested against being called upon actually to produce her.

Two points of pedagogic importance were made. First, there is geometry. In Prof. Eddington's opinion geometry is not the science of space relations in an empty world, but the science of space relations of material objects; its fundamental assumptions are to be ascertained by measurements made on such objects. From this it would follow that the philosophical way to begin the study of geometry is by playing with mathematical instruments and bits of cardboard. This is what teachers have been discovering, beginning at the other side of the problem—beginning, that is, with the boy into whom they have to insert learning. Prof. Eddington reaches the same conclusion by considering the nature of the learning that is to be inserted into the boy. So the two sets of workmen meet in the middle of the tunnel and the line is clear for traffic.

Secondly, there is dynamics. Consider the case of a pendulum. On one side of the equations we have been accustomed to write the forces, including gravity. On the other we write inertia and acceleration, including the acceleration towards the centre. But the last term could algebraically be written on the force side, with sign reversed; it would be identified with what has been known popularly as centrifugal force. Teachers have generally been rather prudish about this term, but Prof. Eddington assures us that centrifugal force and weight are equally real or unreal; it would appear, then, that they should be on the same side of the equation. (But which side?) Similarly, the passenger walking along the aisle of an accelerating tube-carriage is justified in considering himself in equilibrium under a pressure from the floor and a gravitational force equally inclined to the vertical; and gravity is, in practice, not disentangled from the centrifugal force of the earth's rotation.

Dr. Brodetsky followed with a paper proposing to inject fresh blood into dynamics by using the aeroplane. He explained that the problem could be so simplified that, after a year's study of dynamics, the student could work problems on the motion of aeroplanes, including climbing, *vol plané*, and banking. We shall look forward to seeing these suggestions worked out in detail in a forthcoming issue of the *Mathematical Gazette*.

The Rev. S. H. Clarke, of Tonbridge School, pleaded for a more intelligent handling of the older non-mathematical boys, especially those of proved ability in classics. They should not be allowed to drop mathematics, nor should their time be spent in trying to attain an unattainable degree of dexterity in the bits of mathematics that they have already learned to dislike. On the contrary, they should be introduced in a superficial and literary manner to new mathematical regions; here they will find fresh inspiration, and eventually form a public able to view mathematical achievements with sympathy and appreciation. Mr. Durrell recorded that such a scheme has been in operation at Winchester for two years; that it is compatible with success in the school certificate examination; and that examination results on the wider field are bound to be bad. But this does not matter in the least.

Prof. Whittaker, the retiring president, indicated the danger that mathematicians might break up into two non-communicating groups: researchers who do not teach much, and teachers (mainly schoolmasters) who do not research. This was by no means necessary, as the Edinburgh Mathematical Society does useful research work and is composed almost entirely of schoolmasters. There were many problems which might be attacked with fruitful results by schoolmasters whose knowledge does not go beyond an honours course. He described three fields in which oil might be struck near the surface with a very moderate drilling equipment:—(1) A method allied to nomography, at present almost unexplored; (2) the theory of skew determinants and Pfaffians; and (3) the solution of partial differential equations by means of integral equations.

Canon J. M. Wilson, the new president, gave an account of the efforts of mathematical reformers before the foundation of the Association for the Improvement of Geometrical Teaching, now the Mathematical Association (the fiftieth anniversary of this event occurs this year.) He was asked by Dr. Temple, then Headmaster of Rugby, to produce a reformed geometry text-book; this he did after consulting the leading Continental works on the subject. In appreciation of his work he received an address in Edinburgh signed by Members of Parliament, professors, and other leading men. Those on whose shoulders Canon Wilson's mantle has fallen have done little more than to rediscover or develop the ideas put forward by himself and other pioneers more than fifty years ago. Canon Wilson will be pleased to learn that his ideas have now been accepted by all the important examining bodies except London University.

Miss E. B. Read told an interesting story of a recent visit to lycées in Paris and the French provinces—girls' schools, all of them; in boys' schools she never penetrated beyond the director's office. She was impressed by the burden of home-work in these lycées, sometimes occupying the girls up to midnight. This she associated with the predominantly oral method of classwork, little time being spent in working examples in class. C. G.

The Geographical Association.

The annual meetings of the Geographical Association were held in the London Day Training College, Southampton Row, on January 7–8. The session opened with a discussion on historical geography, led by Messrs. Fairgrieve and Jervis. Several historians were present, and they agreed with geographers that each subject demands not only a special and intensive study of its own facts, but also a special and differing attitude of mind. Every geographer must have sufficient knowledge of historical facts and conditions to explain those links of the past which last on into the present, and are thus necessary to the proper understanding of present geographical conditions. Prof. J. L. Myres said that both history and geography were concerned in the effort to help young folk to exploit the general experience of humanity for their own benefit and that of their fellow-citizens, and that it was therefore imperative that the two sets of aspects should be presented harmoniously and instructively.

In the discussion on geography in continuation schools the main point which emerged was that geography was being given a place in the L.C.C. schools because it was felt that it gives a training in good citizenship, in a habit of wide outlook, and in interest in the district in which the pupil lives or works.

Dr. Unstead gave a remarkably able exposition of the difficulties and possibilities which face the teacher of geography in his attempts to deal with such international problems as the altered environmental and psychical conditions in eastern Europe, the racial question on the Pacific fringes, and the atmosphere in India and Egypt. While it would obviously be crude to discuss these things in a political way, even in the upper forms of secondary schools, it is yet essential that these aspects of modern human geography shall be presented, and the only safe way is to show the contrasted *ideals* rather than the detailed claims of each nationality.

Dr. Haddon, whose valuable expedition to the Torres Strait was one of the outstanding scientific events of the last generation, delivered an illustrated lecture on racial and cultural distributions in New Guinea, furnishing thereby a first-rate example of the methods of distributional study.

Prof. Gilbert Murray gave his presidential address on the evening of January 8. He emphasised the fact that in every epoch of history there has been a division of humanity into the select few who understand the world and the barbaric multitude who are without the precinct—the Hellenes and the Barbarians, in mediæval times the world of Christianity, and without the pale the Jews and infidels. The essential mark of the man "without the precinct" is that the motives which underlie his actions are misunderstood, or even not considered at all. Geography should help to remove that spirit of ignorance and misunderstanding from the world. For geographers the present world-situation is of special interest, for not only have the Great Powers been compelled to try to get this spirit of mutual geographic understanding, but also the whole *orbis terrarum* is meeting. China and Peru are members of that League the business of which is the common good of humanity, the securing not merely of *peace*, but also of goodwill between every nation of the world, whatever its status.

The lectures given by Dr. Haddon and Prof. Gilbert Murray will be published in the spring number of the *Geographical Teacher*, which is sent post free to all members of the Geographical Association. The annual subscription is 5s., and the address of the central offices is 1 Marine Terrace, Aberystwyth.

The Origin of Hypergamy.

At a meeting of the Royal Anthropological Institute held on November 9, Mr. S. H. Ray, vice-president, in the chair, Dr. W. H. R. Rivers read a paper on "The Origin of Hypergamy."

Dr. Rivers said that the term "hypergamy" had been used loosely by both Sir Herbert Risley and Dr. W. Crooke to denote marriage between groups which differ in rank, but for the sake of clearness the term should be confined to those instances in which there was a characteristic difference between the marriage rules for the two sexes. Hypergamy thus understood was that form of marriage in which men mate with women of lower rank than their own, but do not give their women in return, the union of these being confined to men of their own or higher grades. Owing to the fact that women of the highest group can only marry men of their own rank, women of high rank either remain unmarried or the inequality is redressed by the practice of polygyny or by female infanticide. On the other hand, since men of the lowest grade may only marry women of their own rank, while such women are taken by men of a higher group, there is a shortage of women of the lowest grade, and the men must remain unmarried or have recourse to polyandry, or they may seek their wives elsewhere. If the neighbouring communities are hypergamous or endogamous, the only unions open to them will be with any aboriginal women who may live in the neighbourhood. The practice of hypergamy is not only peculiar to India, but is there almost entirely confined to the Rajputs, or castes, such as the Kulin Brahmans, which have come under Rajput influence. Where the custom occurs among the castes of Bengal, it would seem to have been derived from the Kulins. It appears probable that the Kulin custom can be traced to Rajput influence, as the Kulins are derived from Brahmans who about A.D. 700 came to Bengal from Kanauj, at one time the centre of Rajput rule. Hypergamy also occurs among the Nayars of Malabar, but in this case its relation to the practice in other parts of India is not so clear. One form arises out of their relation with the Nambutiri Brahmans, among whom the rule is that only the eldest son may marry; the other sons contract unions with Nayar women. A Nambutiri woman would not be allowed to marry a man, Nayar or other, of a lower caste. The status of the children is determined by the Nayar rule of matrilineal descent. There is no evidence to connect the practice among the Nayars and other cases occurring sporadically in the Madras Presidency with Rajput influence, and it is possible that with them it may have a more ancient history and go back to a remote derivation from the warrior caste.

The institution of hypergamy appears to be a special form of interaction between immigrants into India and the indigenous population, and to be an intermediate stage between the complete fusion which has taken place in such cases in other parts of the world and the segregation which has produced the more characteristic forms of the caste system of India. The development of hypergamy may be referred to three special conditions: (1) The especial strength of a sentiment of the immigrants concerning the union of their women with indigenous men; (2) a short distance of migration, so that the immigrants were accompanied by a relatively large number of women; and (3) the military character of the invaders, which allowed them to obtain indigenous women without giving their own women in return.

An interesting discussion followed the reading of the paper, in which emphasis was laid upon the importance of the principles formulated by Dr. Rivers in their bearing upon questions of racial admixture and fusion of language as a result of peaceful penetration or invasion in other parts of the world. Prof. Parsons pointed out that the Saxons had brought a large number of women with them to this country, as was shown by the skeletal remains, whereas the Norsemen who invaded France constituted a male invasion solely, and this probably explained the almost complete substitution of French among them for their own language, the language of the native mothers having prevailed. Mr. Ray pointed out that while the words denoting close family connection in this country were predominantly Saxon, the language of the children contained Celtic elements, as, for example, the word "dad." Prof. C. G. Seligman said that he had found a practice similar to hypergamy among nomad Arab tribes of the Sudan, in which black slaves, the offspring of Arab men and indigenous women, although permitted to hold very high office in the tribe, were not allowed to marry Arab women. Col. Hodgson pointed out that the restriction of marriage to the eldest son also existed among the Kyasths, the reason in this case being that that son was the only true reincarnation of the father, his younger brothers being the "children of sin."

Studies in British Forestry.[1]

The Forestry Commission has made a good start, having acquired during the first year of its operations as many as 65,000 acres of land, of which 1500 acres have been planted with trees. During the present year 5900 acres of new plantations are planned. These figures are well ahead of the schedule of the first two years' work which was laid down in the Reconstruction Forestry Sub-Committee Report. This is satisfactory as regards the part played by the State in national afforestation, but we must not forget the work to be done by landowners in replanting the extensive areas which were felled during the war.

The Forestry Commission can assist private enterprise by money grants for planting, by partnership schemes, and by providing nursery plants at a cheap rate, but it can also stimulate owners to active measures of afforestation by the publication of trustworthy facts and figures concerning all forestry matters. We welcome, then, the three interesting bulletins which have been recently issued. Technical skill in the rearing and planting of trees is not lacking in this country, but much ignorance prevails as to the actual results obtainable by afforestation with different species of trees. Bulletins Nos. 1 and 3 are concerned mainly with this question, and their perusal will enable owners to deal intelligently with some problems of replanting and afforestation.

A survey for the collection of statistics as to the rate of growth and production of timber in the United Kingdom was carried out officially in 1917–19, and

[1] Forestry Commission. Bulletin No. 1: "Collection of Data as to the Rate of Growth of Timber." (To be obtained from the Forestry Commission on sending 4d. and a stamped addressed envelope.) Bulletin No. 2: "Survey of Forest Insect Conditions in the British Isles, 1919." (H.M. Stationery Office.) Price 1s. 6d. net. Bulletin No. 3: "Rate of Growth of Conifers in the British Isles." (H.M. Stationery Office.) Price 3s. net.

Bulletin No. 1 gives an account of the methods which were actually used by the forest officers in charge of the survey. These methods are based on the measurement of well-stocked sample plots of woods of various ages and on all classes of soils. Five working parties were employed, the actual measurements being made by women assistants under the supervision of a skilled officer who inspected the woods and selected the plots. This bulletin is clearly written, and will prove useful to private owners wishing to lay out sample plots by means of which they will be enabled to measure the volume and increment of their own woods by official and scientific methods.

The third bulletin deals with the results of the survey which was restricted to pure woods of conifers. It furnishes us for the first time with accurate yield-tables of larch, Scots pine, and spruce based on accurate measurements of these species in British plantations. Hitherto we were dependent on Continental yield-tables, which apply only very approximately to this country. Provisional tables for Douglas fir, Japanese larch, and Corsican pine are also given in the bulletin. The yield-tables are of the usual kind, giving for various qualities of soils the average height and diameter of the trees and the number of stems and volume of timber per acre, with other figures, corresponding to ages of 10, 15, 20, . . . 100 years. Any wood, provided its age is known, can be allocated to its proper quality class by the average height of the trees, as it is well established that in a fully stocked wood of any species the volume at a given age is in direct relation with the mean height.

A considerable part of Bulletin No. 3 is taken up with a discussion on the factors of climate and soil in relation to the growth of species, like Scots pine, larch, and spruce. This branch of the subject is very important, and deserves much more extended investigation than was possible in this preliminary survey.

Bulletin No. 2, prepared by Dr. J. W. Munro, the entomologist employed by the Forestry Commission, is based on a survey of the insect conditions of coniferous woods in seventeen districts of the United Kingdom in 1919. This survey was rendered necessary by the great increase in harmful insects occasioned by the heavy fellings of timber during the years of the war. Owing to the shortage of labour it was impossible to clear the ground of the branches and débris which, with the stumps of the trees, form the main breeding-grounds of these pests. Dr. Munro investigated the ravages of fifteen species of insects, and reports that coniferous woods generally are in a very unhealthy state. Young plantations on the site of, or near, a felled area suffer most. This bulletin is well illustrated, and Dr. Munro's remarks on measures of prevention should be studied carefully by all foresters engaged in the formation of new plantations.

Greenland in Europe.[1]

By DAVID MACRITCHIE.

AT the present day the name "Greenland" is limited to the great island lying to the east of Arctic America. Formerly, however, it included an undefined territory of Arctic and sub-Arctic Europe, extending eastward, according to some estimates, into north-western Siberia. Sir William Martin Conway has shown (Hakluyt Series, 1904) that during the seventeenth century, in Britain and the neighbouring countries, "Greenland" primarily denoted Spitsbergen. Even in the year 1812 the leading London publishers were selling a school-book which, ignoring the word "Spitsbergen" altogether, applied to that group of islands the sole name of "Greenland."

But so early as the time of the Norman conquest of England a German chronicler, a minor canon of the Cathedral of Bremen, widely known as "Adam of Bremen," had recorded the existence of a Greenland in Northern Europe. There is good reason for assuming that the region he had in view was the Kola Peninsula and a good deal of contiguous territory. He states that those Greenlanders were *caerulei* (blue men), and that they were cruel, "troubling seafarers by predatory attacks"—from which it may be inferred that they were themselves seafarers. In passing, it may be pointed out that at a very much earlier date the Romans had noted the existence of a caste of *caerulei* in the British Isles. In both cases the name probably arose from the custom of painting or tattooing with blue pigments.

The assumption that Adam of Bremen's "Greenland" was the Kola Peninsula and the parts adjoining receives confirmation from a statement made in 1430 by a Danish traveller and writer of the name of Claus Claussön, Latinised Claudius Clavus; for he tells us, from personal knowledge, that at that time "the infidel Karelians daily come to Greenland in great armies." The Karelians, or Karels, a Finnish people, occupied most of the south-western shores of the White Sea in the fourteenth century. In the fifteenth century they ousted the Lapps from their homes on the western shore of the White Sea, driving them north into the Kola Peninsula. The country thus taken possession of by the Karels is now known as Karelia. But the name applied to it by Claudius Clavus was "Greenland."

To make it quite clear that Clavus referred solely to a European country when he spoke of "Greenland," it is necessary to keep in view the fact that in 1430 there was no European intercourse with the Greenland on the other side of the North Atlantic. The situation is definitely explained by Dr. Nansen, who states ("Encyc. Brit.," eleventh edition, vol. xii., pp. 542 and 548) that the last ship known to have visited the Norse colony in trans-Atlantic Greenland returned to Norway in 1410, and that from that date until 1585 the overseas Greenland was unvisited by Europeans and almost forgotten. It is therefore manifest that when any trustworthy writer of the period 1410–1585 makes reference to Greenlanders as people with whom Europeans are then in contact, he has in view a North European race, and not a race living on the other side of the Atlantic.

A further statement by Clavus has a distinct bearing upon this question. He tells us that to the west of the wild Lapps "are little pygmies, whom I have seen after they were taken at sea in a little skin-boat, which is now [about 1430] hanging in the cathedral at Nidaros [*i.e.* Trondhjem]. There is likewise a long vessel of hides, which was also once taken with such pygmies in it." Again, Olaus Magnus relates how in 1505 he saw two of the leather skiffs of "the Greenland pirates" hanging in the cathedral at Oslo (Christiania). And Jacob Ziegler, in his work "Srondia" (1532), speaks of the "light boats of hide" of the Greenlanders. A complaint

[1] Synopsis of a paper read before the British Association (Anthropological Section) at Cardiff on August 27, 1920.

against "the Greenland pirates" in their "small ships without keels" is made in 1551 by Carsten Grip, Mayor of Kiel.

Visits of similar people in skin canoes are recorded in the Orkney Islands by writers of unimpeachable veracity in the seventeenth century. One of these canoes is still preserved in the anthropological museum of Marischal College, Aberdeen. Its framework and implements are made of North European wood. The estimated maximum height of its occupant is 4½ ft.

A vast field of conjecture opens up if we begin to consider the European skin boat in the first thousand years of the Christian era. Von Düben shows that it was the earliest boat used by the Lapps, and Prof. Julius Pokorny interprets the *Fir Bolg* of Gaelic lore as "skin-boat men." "The Greenlandish Attila Lay" is said to date from the eighth or ninth century.

Prize Awards of the Paris Academy of Sciences.

Mathematics.—Grand prize of the mathematical sciences to Ernest Esclangon, for his memoir entitled "New Researches on Quasi-periodic Functions"; the Poncelet prize to Elie Cartan, for the whole of his work; the Francœur prize to René Baire, for his work on the general theory of functions.

Mechanics.—A Montyon prize to Stéphane Drzewiecki, for his book on the general theory of the helix, with reference to marine and aerial propeller-blades; the de Parville prize to Jean Villey, for his work on internal-combustion motors. No memoir was received dealing with the question proposed for the Fourneyron prize, but the arrears accrued are divided between Joseph Auclair and Alfred Boyer-Guillon (1000 francs), for their theoretical and practical studies on the measurement of the acceleration of a point of a body subject to a periodic motion, and Eugène Burlot (1000 francs), for the whole of his work concerning the propagation of waves of shock in air and water.

Astronomy.—The Lalande prize to Léopold Schulhof, for his revision of the catalogue of the proper motions of 2641 stars published by J. Bossert in 1896; the Valz prize to Ernest Maubant, for the whole of his work on the calculation of the perturbations of comets; the Janssen medal to William W. Coblentz, for his work on the infra-red radiation of terrestrial sources and of stars; the Pierre Guzman prize between François Gonnessiat (5000 francs), for his work on the photography of the minor planets, René Jarry-Desloges (5000 francs), for his physical observations on the planets, especially Mars, and Joanny-Ph. Lagrula (4000 francs), for his work on the rapid identification of the minor planets. The Damoiseau prize was not awarded, and the questions proposed for 1917 and 1920 are again proposed for 1923.

Geography.—The Delalande-Guérineau prize to Georges Bruel, for the whole of his explorations and publications relating to French Equatorial Africa; the Tchihatchef prize to Auguste Chevalier, for his explorations in Africa and Indo-China; the Binoux prize to Marcel Augiéras, for his work in the western Sahara. The Gay prize is not awarded.

Navigation.—The prize of 6000 francs between Fernand Gossot (4000 francs), for his treatise on the effects of explosives, Pierre de Vanssay de Blavous (1500 francs), for the whole of his work, and René Risser (500 francs), for his work on ballistics; the Plumey prize between Charles Doyère (2000 francs), for the whole of his work, especially for the services which he rendered during the war, and Edouard Tournier (1000 francs), for his book entitled "Practical Guide for the Use of Mechanics for Calculating the Internal Losses in Machines and Determining their Yield."

Physics.—The L. La Caze prize to Georges Sagnac, for the whole of his work in physics; the Hébert prize to Léon Bouthillon, for his work and publications on wireless telegraphy; the Hughes prize to Frédéric Laporte, for his work on electrical standards and the photometry of electric lamps; the Clément Félix foundation to Amédée Guillet, for his researches on chronometry.

Chemistry.—The Montyon prize (unhealthy trades) to Léonce Barthe, for his work on the hygiene of workshops, a mention (1500 francs) to Paul Goissedet, for his work in relation to poison gas, and a mention (1000 francs) to Henri Guinot, for his chemical work during the war; the Jecker prize (5000 francs) between Henri Gault, for his work in organic chemistry, and Henri Hérissey, for his researches on the glucosides of plants; the L. La Caze prize to Robert de Forcrand, for the whole of his work in inorganic chemistry; the Cahours foundation between Raymond Cornubert, for his work in the *cyclo*hexanone series, and Paul Robin, for his chemical studies in relation to the war and for his work on the oximes; the Houzeau prize to the late Emile Baud, for his researches on the compounds of aluminium and arsenic and his work in the national defence.

Mineralogy and Geology.—The Fontannes prize to Olivier Couffon, for his work entitled "Le Callovien du Chalet (Commune de Montreuil-Bellay)"; the Joseph Labbé prize to Albert Bordeaux, for his applications of geology to the solution of mining problems. The Victor Raulin prize is postponed until 1921.

Botany.—The Desmazières prize to André Maublanc, for his work in mycology and plant diseases, an honourable mention to Pierre Sée, for his book on the diseases of paper; the De Coincy prize to Lucien Hauman-Merck, for the whole of his botanical work. The Montagne prize is not awarded.

Anatomy and Zoology.—The Cuvier prize to Alphonse Malaquin, for the whole of his work in zoology; the Savigny prize to F. Le Cerf, for his "Revision des Ægeriidés algériens"; the Jean Thore prize to A. Cros, for his biological studies of the Coleoptera of northern Africa.

Medicine and Surgery.—Montyon prizes to Pierre Delbet and Noël Fiessinger (2500 francs), for their memoir on the biology of war wounds, Joseph Franchini (2500 francs), for his studies on the pathogenic protozoa, and François Maignon (2500 francs), for his researches on the *rôle* of fats in the utilisation of albuminoids. Honourable mentions (1500 francs) to Henri Alezais and Albert Peyron, for their researches on the histogenesis of certain groups of tumours, to Maurice Heitz-Boyer, for his researches on the physiology and surgery of bone, and to P. Lassablière, for his studies on milk and feeding of new-born infants. A citation to Joseph Rigaut and Antoine Orticoni, for their work entitled "L'évolution de la croissance chez les adénoïdiens"; the Barbier prize to Albert Berthelot, for his chemical work on intoxications of intestinal origin; the Bréant prize between Auguste Marie and Constantin Levaditi (3000 francs), for their work on general paralysis, and Henri Violle (2000 francs), for his memoir on cholera; the Godard prize to Henry Chabanier, for his study of the numerical laws of the renal secretion; the Mège prize is not awarded;

the Dusgate prize, Jules Leclercq receives an encouragement (1000 francs) and Albert Terson an encouragement (500 francs), for work on the signs of death; the Bellion prize to Maurice Courtois-Suffit and René Giroux, for their memoir on cocaine, and an honourable mention is accorded to Jean Bec and André Pérès, for their work entitled "Mémento d'hygiène à l'usage des instituteurs de l'Afrique occidentale française"; the Baron Larrey prize to J. Peyrot, for his study on social medicine in the Bavarian Palatinate, and a very honourable mention is accorded to Flavien Bonnet-Roy and to Pierre Talon.

Physiology.—A Montyon prize to Emile Terroine, for his important work on the evolution of fatty materials in the organism; the Lallemand prize to Paul Sollier, Marius Chartier, Félix Rose, and Ch. Villandre, for their book entitled "Traité clinique de neurologie de guerre," and a very honourable mention is accorded to André Guillaume; the L. La Caze prize to Maurice Arthus, for his physiological work, especially his researches on the coagulation of milk and blood and on sero-anaphylaxy; the Martin-Damourette prize to François Heymans, for his memoir on thermo-physiology; the Philipeaux prize to Charles Dhéré, for his work on hæmocyanine.

Statistics.—A Montyon prize to Eugène Fournier, for his work entitled "Gouffres, Grottes, Cours d'eau souterrains du Départemente du Doubs," and a mention (500 francs) to Fr. M. Messerli, for his contribution to the study of physiological corporal growth between the ages of nineteen and thirty-two.

History and Philosophy of the Sciences.—The Binoux prize between Edouard Doublet (1000 francs), for his various historical publications, and Jean Mascart (1000 francs), for his book on the life and work of Jean Charles de Borda.

Medals.—Berthelot medals to Léonce Barthe, Henri Gault and Henri Hérissey, and Robert de Forcrand de Coiselet.

General Prizes.—The Bordin prize to Jacques de Lapparent, for his studies on sedimentary breccia; the Serres prize equally between Octave Duboscq and Louis Léger, for the whole of their work on protistology and general embryology; Vaillant foundation, a subvention of 4000 francs to Paul Le Rolland, for his researches on the oscillation of the pendulum; the Houllevigue prize between François Gagnepain (3000 francs), for his studies on the flora of the East, and Canon Bourgeat (2000 francs), for the whole of his geological work; the Saintour prize to Paul Bertrand, for the whole of his work on palæophytology; the Lonchampt prize to Eugène Lambling, for his researches in organic and biological chemistry; the Caméré prize to Gaston Pigeaud, for his work in civil engineering; the Gustave Roux prize, for his researches on the gases issuing from thermal springs, petroleum wells, coal-mines, etc., with special reference to determination of the rare gases and radioactivity; the Thorlet prize to Adolphe Richard, for his bibliographical work.

Special Foundations.—The Lannelongue foundation divided between Mmes. Cusco and Ruck; the Laplace prize to Charles René Drouard and Paul Maurice Ferdinand Roy; the L. E. Rivot prize between Charles René Drouard, Paul Maurice Ferdinand Roy (each 750 francs), Edmond Friedel, Léon Migaux (each 500 francs), Raymond Alexandre Auguste Fleury, Jean Lapedie (750 francs), Jean Gérard Rouelle, George Jules Lucien Couprie (500 francs).

Foundations for Scientific Research.—The Trémont foundation to Charles Frémont, for his researches on tools; the Gegner foundation to Paul Hallez, for the whole of his zoological work; the Jérome Ponti foundation to Paul Nicolardot, for his analytical researches and work for the national defence.

The Bonaparte Fund.—Out of fifteen applications eight grants were approved to the following:

2000 francs to R. Anthony, for the publication of the catalogue of the collections of osteology in the comparative anatomy section of the National Museum of Natural History.

2000 francs to Philippe Eberhardt, for his researches on the flora of Indo-China.

2000 francs to Henri Martin, for his La Quina excavations (Charente). Of the material collected the human remains are to be sent to the Natural History Museum, and other objects to the Saint Germain Museum.

4000 francs to Emile Mathias, for his researches (in collaboration with M. Kamerlingh Onnes) of the curve of densities of gases the critical point of which is near the absolute zero (hydrogen, neon).

2000 francs to Jacques Pellegrin, for his researches and publications concerning the fishes of the French Colonies.

2000 francs to Charles Pérez, for his researches and publications on the crustaceans (Epicarideæ) of the Persian Gulf.

2000 francs to René Souèges, for his work on the embryogeny of the higher plants.

2000 francs to P. Wintrebert, for his researches on the automatism of the locomotor movement in the embryos of Selacians.

Charles Bouchard foundation to Charles Vaillant, for his work in radiography.

University and Educational Intelligence.

Cambridge.—Major-Gen. the Right Hon. J. B. Seely has offered to endow a University prize for the best essay on a subject connected with aeronautics. —Mr. F. A. Potts, Trinity Hall, has been appointed demonstrator of comparative anatomy.—Regulations have now been drawn up for the Sir William Dunn professorship of biochemistry, founded under the terms of the benefaction offered to the University last summer.

Mr. A. R. Hinks, the Gresham lecturer on astronomy, will deliver four free public lectures on "The Motions of the 'Fixed' Stars" in Gresham College, Basinghall Street, E.C., at 6 o'clock on January 18 to 21.

The Camborne School of Mines, Cornwall, has issued an appeal for donations towards a memorial in honour of those members of the school who fell during the war. It is proposed to purchase a playing-field and to erect a grand stand on it, on which a memorial tablet will be placed. Communications should be addressed to the Hon. Secretary, Memorial Committee, The School of Mines, Camborne.

We have received the prospectus of the Faculty of Medicine of the University of Paris for the academic year 1920–21. It includes full particulars of the general organisation of the faculty and of the courses of instruction at the schools and clinics of the University. In addition to the regular courses various revision and advanced courses are also given, and practically all the subjects of the medical curriculum are dealt with. The pamphlet is published by Masson et Cie, 120 Boulevard Saint-Germain, Paris, VI., price 1 franc net.

It is announced that Mr. W. Edmonds and Miss S. Edmonds have founded a prize in ophthalmology in memory of their brother, Nicholas Gifford Edmonds, who fell at Magersfontein on December 11, 1899. The prize is 100*l*., and it will be awarded every two years for the best essay on a subject dealing with ophthalmology and involving original work. The competition will be open to all British subjects holding a medical qualification. A committee nominated biennially by the Medical Board of the Royal London Ophthalmic Hospital will have the adjudication of the prize.

Two Theresa Seessel research fellowships, each of the yearly value of 300*l*., are being offered in connection with Yale University for the promotion of original research in biological studies. Preference will be given to candidates who have obtained their doctorate and demonstrated by their work their fitness for carrying out successfully original research work. Applications for the fellowships, with reprints of scientific publications, letters of recommendation, and particulars as to the problems proposed by the candidates, must be sent before May 1 next to the Dean of the Graduate School, New Haven, Conn., U.S.A.

Reference was made in these columns some time ago to the Imperial College War Memorial and Athletic Ground scheme. It now appears from papers issued recently that the enterprise has received a large measure of support from friends and old students of the college and its constituent parts, the City and Guilds Engineering College, the Royal College of Science, and the Royal School of Mines. Up to the middle of November a sum of more than 6300*l*. had been subscribed, and the early response to the appeal has been sufficiently satisfactory to enable the committee not only to proceed with the erection of the memorial tablets in the college buildings, but also to complete the purchase of a sports field at North Wembley, over which an option had been secured. Some of the college clubs are already utilising the ground for the purposes of football and hockey. The further sum immediately required to cover outlay on the memorial tablets, the purchase of the ground, and necessary expenses, including payment of the mortgage, is about 2500*l*., and the committee is appealing to all friends and old students who have not yet contributed to take a hand in bringing the undertaking to a completely successful issue.

A programme of university extension lectures for the coming term has been issued by the University of London. Courses of lectures will be delivered at about seventy local centres in different parts of London and the surrounding district. The subjects treated cover a wide range, and courses in literature, history, art, architecture, and economics are included in the list; in the direction of teaching of a non-vocational character important work is being done by the Board. When, however, we remember that the report of Sir J. J. Thomson's Committee on the position of natural science in our educational system emphasised the value of lectures which bring home to the general public the meaning of science and its importance in the life of the nation, it is astonishing to note that only two courses of the ninety-nine which are advertised—one by Prof. J. Cox on "The Bases and Frontiers of Physical Science" and the other by Mr. L. Tayler on "Human Biology and Welfare Problems"—are in any way related to natural science. Prof. Cox's course of thirteen lectures will be delivered weekly, starting on January 14, at Gresham College, Basinghall Street, E.C.2; Mr. Tayler's course, consisting of twenty-four lectures, will be given on Mondays at the Technical Institute, Adelaide Road, Leyton. Particulars of the courses can be obtained from the Registrar, University Extension Board, University of London, South Kensington, S.W.7.

Calendar of Scientific Pioneers.

January 14, 1742. Edmund Halley died.—The son of a rich London soapmaker, Halley began his astronomical work at Queen's College, Oxford, at the age of seventeen, and continued it until his death at the age of eighty-five. The friend of Newton, he succeeded Wallis as Savilian professor of geometry, Flamsteed as Astronomer-Royal, and Hans Sloane as secretary of the Royal Society. His name is associated with the study of the trade winds, the variation of the compass, Halley's comet, and many fundamental points in astronomy. To his "great zeal, able management, unwearied perseverance, scientific attainments, and disinterested generosity" was largely due the publication of Newton's "Principia." Halley is buried at Lee, near Greenwich, in the same tomb as Pond, Astronomer-Royal from 1811 to 1835.

January 14, 1874. Philipp Reis died.—While teaching at Friedrichsdorf, near Hamburg, Reis in 1861 constructed a telephone which was used with good results by Hughes in 1865, but Reis died when forty years of age, poor and almost unknown.

January 14, 1890. Gustave Adolphe Hirn died.—An engineer and physicist of Alsace, Hirn was a pioneer in the scientific testing of steam-engines.

January 14, 1905. Ernst Abbe died.—Born in 1840, Abbe, while a professor at Jena in 1866, joined Carl Zeiss and devoted himself to the theoretical investigation of optical instruments. His report on the South Kensington Loan Collection of Scientific Apparatus of 1876 led to the co-operation of the glass-maker, Otto Schott, and "Jena" glass became famous the world over.

January 14, 1906. Hermann Johann Philipp Sprengel died.—Trained as a chemist in Germany, Sprengel settled in England. He made notable advances in explosives, and by his invention of the mercurial air-pump rendered possible the Swan and Edison glow-lamps, Crookes's radiometer, and the Röntgen X-ray tube.

January 16, 1806. Nicolas Leblanc died.—The discovery of how to make soda from salt was, by J. B. Dumas, compared in importance with the improvement of the steam-engine by Watt. Leblanc made the discovery in 1787, and his patron, the Duke of Orleans, erected a factory for him. In 1793 the duke was guillotined, the factory confiscated, and Leblanc's patent cancelled. After years of poverty Leblanc's mind gave way and he shot himself. A statue of him now stands in the Conservatoire des Arts et Métiers.

January 17, 1910. Friedrich Kohlrausch died.—The successor in 1895 of Helmholtz at the Physikalisch Technische Reichsanstalt, Kohlrausch was an authority in the field of accurate physical measurement.

January 18, 1878. Antoine César Becquerel died.—Becquerel served in the French Army until the peace of 1815, and then gave himself up to scientific pursuits. A voluminous writer, he was a founder of electro-chemistry, for his work on which he received in 1837 the Copley medal of the Royal Society. His statue stands at his birthplace, Châtillon-sur-Loing.

January 19, 1878. Henri Victor Regnault died.—Distinguished alike as a chemist and physicist, Regnault's great researches on the expansion of gases were made at the Sèvres porcelain factory, of which he was director, but much of his later work was destroyed during the Franco-German War.

E. C. S.

Erratum.—In last week's Calendar the year of Galileo's birth should have been 1564, and not 1571, which was the year Kepler was born.

Societies and Academies.

SYDNEY.

Linnean Society of New South Wales, October 27.—Mr. J. J. Fletcher, president, in the chair.—E. W. **Ferguson** and G. F. **Hill**: Notes on Australian Tabanidæ. The paper deals mainly with synonymy, the results being given of comparison of specimens with the types of Australian Tabanidæ in the British Museum and in the Australian Institute of Tropical Medicine. Seventeen species belonging to five genera are dealt with, one species being described as new.—Dr. A. J. **Turner**: Studies in Australian Lepidoptera: Liparidæ. In Australia the family Liparidæ is represented by sixty species belonging to eighteen genera, of which two genera and ten species are described as new in this paper.—G. A. **Waterhouse**: Descriptions of new forms of butterflies from the South Pacific. One species from Fiji and six subspecies from Fiji (three), Lord Howe Island (two), and the New Hebrides (one) are described as new.—Eleanor E. **Chase**: A new avian trematode. A species of Holostomum is described as new. The specimens described were obtained from a white-fronted heron, *Notophoyx novae-hollandiae*, at Terrigal, N.S.W.—Dr. J. M. **Petrie**: Cyanogenesis in plants. Part iv.: The hydrocyanic acid of Heterodendron, a fodder-plant of New South Wales. The foliage of *Heterodendron oleaefolia* was much used for cattle-feeding during the drought. Chemical examination of the leaves shows them to contain a cyanogenetic glucoside yielding, when hydrolysed, 0·328 per cent. of hydrocyanic acid. The plant is therefore one of the most poisonous cyanogenetic plants known, yielding more than twice as much hydrocyanic acid as bitter almonds. One ounce of the air-dried leaves forms a lethal amount for one sheep. The leaves are invariably found to be deficient in enzyme, and require the addition of emulsin in the estimation to bring about the complete decomposition of the glucoside.—Vera **Irwin-Smith**: Studies in life-histories of Australian Diptera Brachycera. Part i.: Stratiomyiidæ. No. 1: *Metoponia rubriceps*, Macquart. Very little work has been done in any part of the world on the early stages of the Brachycera; many soil-inhabiting, dipterous larvæ, mostly belonging to the Brachycera, have been collected and reared through to the imago or to the pupal stage. The present paper is the first of a series dealing with this work, and gives a detailed account of the life-history of *Metoponia rubriceps*, Macquart. It is also accompanied by a historical review of published accounts of early stages of the Stratiomyiidæ, a list of the species the earlier stages of which have been observed, and a comprehensive bibliography.

HOBART.

Royal Society of Tasmania, October 11.—Dr. A. H. Clarke in the chair.—L. **Rodway**: Additions to the fungus flora of Tasmania. Several new and interesting species of fungi were described. In his introduction the lecturer pointed out that in any community such as Tasmania, where the future largely depends upon agriculture, the study of botany was essential. It was to be regretted that up to the present this study had been absolutely neglected even at the University. Independent of the injury done by some parasitic fungi to our crops and forests, fungi were of the utmost importance to the well-being of the earth. Their principal work consists of decomposing dead vegetable matter and bringing the soil into a fit state to afford food for plant-life.

Books Received.

Survey of India. Professional Paper, No. 15. The Pendulum Operations in India and Burma, 1908 to 1913. By Capt. H. J. Couchman. Pp. 6+vi+190. (Dehra Dun: Trigonometrical Survey.) 2.8 rupees.

Medical Research Council and Department of Scientific and Industrial Research. Reports of the Industrial Fatigue Research Board. No. 5. Fatigue and Efficiency in the Iron and Steel Industry. (Metal Trades Series, No. 4.) Pp. 99+8 plates. (London: H.M. Stationery Office.) 3s. net.

Cocoa. By Edith A. Browne. (Peeps at Industries.) Pp. viii+88. (London: A. and C. Black, Ltd.) 2s. 6d. net.

Kepler. By W. W. Bryant. (Pioneers of Progress: Men of Science.) Pp. 62. (London: S.P.C.K.; New York: The Macmillan Co.) 2s.

John Dalton. By L. J. Neville-Polley. (Pioneers of Progress: Men of Science.) Pp. 63. (London: S.P.C.K.; New York: The Macmillan Co.) 2s.

Union of South Africa. Department of Mines and Industries. Geological Survey. The Geology of the Northern Portions of the Districts of Marico and Rustenburg. By H. Kynaston and Dr. W. A. Humphrey. Pp. 38. 2s. 6d. The Geology of Pondoland and Portions of Alfred and Lower Umzimkulu Counties, Natal. By Dr. A. L. du Toit. Pp. 45. 2s. 6d. Memoir No. 11. The Limestone Resources of the Union. Vol. ii.: The Limestones of Natal, Cape, and Orange Free State Provinces. By W. Wybergh. Pp. 149. 5s. Memoir No. 15. Corundum in the Northern and Eastern Transvaal. By A. L. Hall. Pp. 223+xxiii plates. 7s. 6d. (Pretoria: Geological Survey.)

South African Mammals. A Short Manual for the Use of Field Naturalists, Sportsmen, and Travellers. By A. Haagner. Pp. xx+248. (London: H. F. and G. Witherby; Cape Town: T. Maskew Miller.) 20s. net.

Diary of Societies.

THURSDAY, JANUARY 13.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—A. S. Eddington: Dr. Sheppard's Method of Reduction of Error by Linear Compounding.—W. F. Sheppard: Conjugate Sets of Quantities.—E. A. Milne: A Problem concerning the Maxima of Certain Types of Sums and Integrals.—H. J. Priestley: The Linear Differential Equation of the Second Order.—M. Kössler: The Zeros of Analytic Functions.—A. C. Dixon: The Theory of a Thin Elastic Plate, bounded by Two Circular Arcs, and Clamped.—G. A. Miller: Determination of all the Characteristic Sub-groups of an Abelian Group.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Sir William Bragg: Electrons (Kelvin Lecture).

CONCRETE INSTITUTE, at 7.30.—H. K. Dyson: Tests on High Tensile Steels.

OIL AND COLOUR CHEMISTS' ASSOCIATION (at 2 Furnival Street), at 7.30.—H. G. Clarke: The Evaluation of White Pigments: with Special Reference to White Antimony Oxide.

OPTICAL SOCIETY (at Imperial College of Science), at 7.45.—Prof. W. Salomonson: A New Ophthalmoscope.—H. Dennis Taylor: An Anastigmatic Flat Field Telescope and its Application to Prismatic Binoculars.—Inst.-Comdr. T. Y. Baker: A Note on Multiple Reflection.

HARVEIAN SOCIETY OF LONDON (at Medical Society of London) (Annual Meeting), at 8.30.—Dr. W. Hill: The Great Advances in the Investigation and Treatment of Diseases of the Œsophagus during the Present Century.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Informal Meeting for Free Discussion.

FRIDAY, JANUARY 14.

ROYAL ASTRONOMICAL SOCIETY, at 5.—E. E. Barnard: Hind's New Star of 1848 (Nova Ophiuchi No. 2).—W. J. Luyten: Note on the Cluster N.G.C. 6633.—Rev. J. G. Hagen: The Astrophysical Problem of Variable Stars.—C. Easton: The Distance of the Galactic Star-clouds.—J. Hargreaves: Note on the Photography of Meteors.—W. M. Smart and H. E. Green: Photographic Magnitudes and Effective Wave-lengths of Nova Cygni (1920), from Photographs Taken at the Cambridge Observatory.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.
JUNIOR INSTITUTION OF ENGINEERS (at Caxton Hall), at 8.—B. E. D. Kilburn: The Tides: Their Cause, Effect, and Use (Chairman's Address).
ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—Dr. R. Pickard: Variations in the Size of the Physiological Cup, and their Relation to Glaucoma.—B. T. Lang: Scotometry.

MONDAY, JANUARY 17.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Bishop E. G. Ingham: Some Reflections on How Empire Came to Us, and Can Alone be Conserved.
INSTITUTE OF ACTUARIES, at 5.—G. King: A Short Method of Constructing Select Mortality Tables.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Keith: The Principles of Craniology applied to Clinical and Racial Problems.
ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Lt.-Col. E. F. W. Lees: International Aeronautical Maps.
INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting) (at Chartered Institute of Patent Agents, Staple Inn Buildings), at 7.—P. Pitt and Others: Discussion on The Mental Equipment of an Engineer.
ARISTOTELIAN SOCIETY (at the University of London Club, 21 Gower Street), at 8.—Prof. G. Dawes Hicks and Others: Discussion on Space, Time, and Deity.
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—H. C. Bradshaw: The Restoration of Praeneste.
CHEMICAL INDUSTRY CLUB (at 2 Whitehall Court), at 8.—H. E. Coley: Some Chemical and Other Notes on His Tour in Borneo.
ROYAL SOCIETY OF ARTS, at 8.—A. E. L. Chorlton: Aero Engines (Howard Lectures).

TUESDAY, JANUARY 18.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Gerald P. Lenox-Conyngham: The Progress of Geodesy in India.
ROYAL STATISTICAL SOCIETY (at Surveyors' Institution), at 5.15.—A. W. Flux: The Measurement of Price Changes.
MINERALOGICAL SOCIETY (at Geological Society), at 5.30.—A. F. Hallimond: The Olivine Group.—W. A. Richardson: A Method of Rock-Analysis Diagrams Based on Statistics.—L. J. Spencer: Identity of Trechmann's "β-tin" with Stannous Sulphide.—Dr. G. F. H. Smith: Linarite, Caledonite, and Associated Minerals from Cumberland.—Dr. G. T. Prior: The Adare and Ensisheim Meteorites.
INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—S. H. Garner: The Carbonisation of Lubricating Oils.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Capt. C. W. R. Knight: Falconry.
ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—J. C. Elvy and Others: Use and Abuse of Light in Studios for Cinema Film Production.

WEDNESDAY, JANUARY 19.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Keith: The Principles of Craniology applied to Clinical and Racial Problems.
GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. L. J. Wills and B. Smith: The Lower Palæozoic Rocks of the Llangollen District, with Especial Reference to the Tectonics.
ROYAL SOCIETY OF ARTS, at 8.—F. M. Lawson: The Future of Industrial Management.
ENTOMOLOGICAL SOCIETY OF LONDON (at 11 Chandos Street, W.1), at 8 (Annual Meeting).
INSTITUTE OF CHEMISTRY (London Section), at 8.—W. G. Young and Others: Discussion on The Institute of Chemistry: What it Can, Cannot, Should, or Should Not Do.
ROYAL METEOROLOGICAL SOCIETY (Annual General Meeting) (at Royal Astronomical Society), at 8.—R. H. Hooker: Forecasting the Crops from the Weather (Presidential Address).
ROYAL MICROSCOPICAL SOCIETY, at 8 (Annual Meeting).

THURSDAY, JANUARY 20.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. A. Harden: Biochemistry (Vitamines).
ROYAL SOCIETY, at 4.30.—*Probable Papers*.—Sir Robert Hadfield, Bart., S. R. Williams, and I. S. Bowen: The Magnetic Mechanical Analysis of Manganese Steel.—Dr. W. S. Tucker and E. T. Paris: A Selective Hot Wire Microphone.—E. A. Milne and R. H. Fowler: Siren Harmonics and a Pure Tone Siren.—Prof. L. V. King: The Design of Diaphragms capable of Continuous Tuning.
LINNEAN SOCIETY, at 5.
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.—Lord Montagu of Beaulieu: The Cost of Air Ton-miles compared with Other Forms of Transport.
INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—R. E. Palmer: Some Observations on Mining by the Opencast or Stripping Method.—E. A. Wraight: The Standardisation of Materials Employed in Mining and Milling Plant.—A. M. Pontie: Notes on the High-level Diamond Deposits of Brazil.
INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates' Meeting), at 8.—W. H. Wardall: Cylinder and Piston Wear.
CHEMICAL SOCIETY, at 8.—J. V. Backes, R. W. West, and M. A. Whiteley: Quantitative Reduction by Hydriodic Acid of Halogenated Malonyl Derivatives. Part I., The Amides of Sym. Dialkyl and Aryl Substituted Amides of Mono- and Di-bromomalonic Acid.—B. M. Gupta: An Investigation on the Influence of Negative Groups of Different Character on the Reactivity of Hydrogen Atoms Carried by the Same Carbon Atom. Part I.—J. Brönsted: The Influence of Salts upon the Chemical Equilibria in Solution.—H. Hepworth: The Action of the Grignard Reagent on Certain Nitric Esters.—G. T. Morgan and H. D. K. Drew: Researches on Residual Affinity and Co-ordination. Part III., Reactions of Selenium and Tellurium Acetylacetones.—G. T. Morgan and D. C. Vining: Dihydroxynaphthaldehydes.—G. T. Morgan: Ortho-chlorodinitrotoluenes. Part II.—C. K. Ingold: The Conditions Underlying the Formation of Unsaturated and of Cyclic Compounds from Halogenated Open-chain Derivatives. Part I., Products Derived from α-Halogenated Glutaric Acids.—A. Findlay and W. Thomas: Influence of Colloids on the Rate of Reactions involving Gases. I., Decomposition of Hydroxylamine in Presence of Colloidal Platinum.—M. Nierenstein: The Constitution of Catechin. Part III., Synthesis of *acacatechin*.—K. G. Naik: The Formation and Properties of Dithioketones ($R_2C{=}S{=}S$) and Dithioethers ($R_2S{=}S$). Part I., The Preparation of Certain Dithioketones and Dithioethers.—W. N. Haworth and E. L. Hirst: The Constitution of the Disaccharides. Part V., Cellobiose (Cellose).—S. H. C. Briggs: The Elements Regarded as Compounds of the First Order.—J. D. Morgan and R. V. Wheeler: Phenomena of the Ignition of Gaseous Mixtures by Induction Coil Sparks.—E. J. Williams: Chloroform Solutions of Hydrogen Chloride.—L. J. Hudleston and H. Bassett: Equilibria of Hydrofluosilicic Acid.—E. Newbery: Chlorine Overvoltages.—P. Rây and P. V. Sarkar: Compounds of Hexamethylenetetramine with Complex Metallic Salts and Acids.
RÖNTGEN SOCIETY (in Physics Laboratory, University College), at 8.15.—M. A. Codd: Increasing the Efficiency of X-ray Tubes by an Improved Design of Coil and Interrupter.

FRIDAY, JANUARY 21.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Prof. R. S. Troup: Indian Timbers.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Keith: The Principles of Craniology applied to Clinical and Racial Problems.
INSTITUTION OF MECHANICAL ENGINEERS, at 6.—H. J. Smith: The Mechanical Loading of Ships.
INSTITUTION OF ELECTRICAL ENGINEERS (at Faraday House, Southampton Row), at 6.30.—H. J. Howard: Electric Welding.

SATURDAY, JANUARY 22.

PHYSIOLOGICAL SOCIETY (at King's College), at 4.

CONTENTS.

NATURE

THURSDAY, JANUARY 20, 1921.

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Scientific Education in the Metropolis.

AMONG the great national problems rendered urgent by the world-war and its consequences not the least important are the highly complex questions affecting the scientific instruction of a large body of students who look to London as their educational Mecca. The matter of adjusting the diverse claims of institutions the interests of which appear to clash is rendered more perplexing and delicate by the circumstance that these establishments embody in varying degrees older policies and ideals of teaching from which it is undesirable and, in point of fact, impossible to separate the educational aims of the immediate future.

The University of London, founded by Royal Charter in November, 1836, when higher education of academic standard was a monopoly enjoyed by the older universities, but refused to many persons on the ground of sex or religious belief, represented an immense increase in the facilities for advanced instruction offered not only in the London colleges, but also in several provincial institutions.

The supplementary Charter of 1858 abolished practically the exclusive connection of the University with these affiliated colleges, and threw open the degrees to all who were prepared to undergo the prescribed examinational tests. This far-sighted development, a practical realisation of the high ideal of "la carrière ouverte aux talents," rendered the University increasingly the *alma mater* of the student whose scanty opportunities for self-improvement compelled him to make use of whatever adventitious aids to education were available within his immediate surroundings.

The University of London Act of 1898, in recognising again the principle of an intimate connection between the University and the principal teaching establishments of the Metropolis, gave a dual aspect to the work of the University, which henceforward had an internal, as well as an external, side to its activities. The dual system is not without difficulties, and at one time it seemed likely that extreme advocates of the internal side would succeed in abolishing the older external side. This step, however, which is less probable now than it was a few years ago, would have extinguished the most characteristic function of the University as an "Imperial institution granting degrees and honours to all comers on condition of examination only."

It is significant of this Imperial aspect of the University's work that in recent years examinational centres have been established in Ireland and Ceylon of which increasing advantage is being taken by the students in those islands. The beneficial effect of this policy is too obvious to need emphasis. The young Irish or Ceylonese graduate, subjected as he probably is to the propaganda of a separatist movement, will view this insidious appeal to his insularity from a somewhat different angle after his affiliation with the metropolitan University; at an impressionable age he will have learnt to think Imperially.

The teaching institutions offering facilities for graduation on the internal side are the three incorporated foundations (University, King's, and the Goldsmiths' Colleges), together with other teaching establishments registered as schools of the University. In addition there are the polytechnics, controlled by the London County Council, which are institutions having recognised teachers, who may arrange their curricula in accordance with the University requirements; students of such courses form an important section of the internal candidates.

The Department of Science and Art, which for many years encouraged the study of science by a national system of examinations and scholarships, provided also higher systematic training and laboratory instruction at the Royal College of Science, with which was incorporated the Royal School of Mines. These two Governmental colleges formed the nucleus of the Imperial College of Science and Technology, which came into being in 1907 by the amalgamation under one governing body of these establishments and the Central Technical College, founded by the liberality of the great Livery Companies acting together through the City and Guilds of London Institute for the Advancement of Technical Education. The Imperial College, which became a school of the University, has since extended the scope of its work by the establishment of several new departments, and, having made good in these varied activities, especially during the war period, now presents itself as a formidable rival of the University in appealing for statutory powers to confer degrees on its *alumni*. In this claim to recognition as a university of technology, the Imperial College points to the established reputation of its staff and the admittedly high standard of its teaching, to the honours gained by its students in the University examinations, and to the scientific interest attaching to the investigations pursued in its research laboratories. From the point of view of the Imperial College, the University examinations are an unnecessary incubus, requiring from their students in November examinational tests precisely similar to those which these candidates passed successfully in the preceding June, sometimes under the inspection of the same examiners.

In order to appreciate the position of the University in the light of this objection, it is desirable to recall the changes which have occurred during the last two or three decades in the regulations relating to degrees in science. Formerly, candidates for the intermediate examination in science were required to qualify not only in mathematics, physics, and chemistry, but also in biology, the requirements in the last-named science being of a generalised but practical character. Moreover, candidates for the B.Sc. with honours were required first to qualify for the pass B.Sc. by examination in any three of the sciences, after which they could present themselves for honours in one or more of the three selected subjects. The effect of these older regulations for the intermediate and pass examinations was to encourage the attainment of a wide knowledge of science and to counteract the evil of premature specialisation.

At present the training in biology has disappeared entirely except for those who wish to specialise in this direction. The broad basis of a knowledge of three sciences is maintained only for those B.Sc. candidates whose natural modesty or lack of self-confidence prevents them from aspiring to the honours standard, where one principal science and one subsidiary subject only are required. The present B.Sc. with honours is in reality a lower measure of comprehensive scientific scholarship than the pass degree; it is largely a degree in physics, chemistry, zoology, or some other single branch of science. The substitution of narrow specialisation for broad scholarship in its science degrees has left the University in this respect with no effective reply to the criticism of the Imperial College. Nevertheless, if the graduate in technology is to be not merely a capable technologist, but also a well-informed member of an enlightened democracy, he will need to learn many things not contained within the purview of a degree in applied science, and it is the proper function of the University to provide him with facilities for acquiring this wider and more liberal education.

On the other hand, the Imperial College cannot hope to establish, and still less can it expect to maintain, a monopoly in applied science. Many teachers of the affiliated schools of the University have in the past made notable contributions to the improvement of industry, and, given adequate facilities for unfettered research, such successes will certainly recur even more frequently in the future. It would be nothing short of a calamity if the tendency towards concentration of educational effort should lead, for example, to the extinction of the Finsbury Technical College, the oldest school of technology in London, which, founded in 1878 by the City and Guilds of London Institute, and developed along original lines by an inspiring band of teachers, including Ayrton, Armstrong, Meldola, Perry, and Silvanus Thompson, has a record of scientific achievement not less meritorious than that of any other college in the metropolitan area. The contemplated closing of this college illustrates one of the risks of over-centralisation; for, while it is vitally important to establish institutions giving the highest specialised instruction and providing the fullest equipment for the most advanced training and research in science, yet due regard must be paid to the claims of the other less pretentious scientific colleges and institutes situated in the various metropolitan boroughs, since these more localised establishments play an important twofold part, first in supplying scientific students sufficiently trained to profit by post-graduate work, and secondly in bringing university teaching within easy reach of the inhabitants of their respective districts.

General Dynamics.

Higher Mechanics. By Prof. H. Lamb. Pp. x+272. (Cambridge: At the University Press, 1920.) Price 25*s.* net.

WE have here, as was to be expected from its author, an excellent statement and explanation of the principal theorems of what may properly be called higher dynamics. Prof. Lamb's title is "Higher Mechanics," which is in accordance with the usage which obtained before the appearance of Thomson and Tait's "Natural Philosophy." In his preface to the "Principia," Newton says: "Mechanicam vero duplicem veteres constituerunt, rationalem, quæ per demonstrationes accurate procedit, et practicam." Thus Newton uses the word "mechanica" qualified by the adjective "rationalis" in the sense of "scientia motuum qui ex viribus quibuscunque resultant," the science of the motions of bodies. The point is not one of great importance, but we prefer with Thomson and Tait the name "dynamics" for the whole science of rational mechanics.

The book begins with chapters on the kinematics of a rigid body, in which degrees of freedom, displacements of a rigid body, and theorems regarding these are very clearly explained and illustrated. Then follows a chapter on statics, in which the usual theorems are set forth, with a short but adequate account of the theory of screws. A treatment of moments of inertia is given which, perhaps, might with advantage have been fuller. Binet's theory of plane quadratic moments is included, while his theorem that the principal axes of inertia at any point P are the normals to the three quadrics which are confocal with the central ellipsoid of gyration, and which intersect at P, is not attributed to its author. The subject of plane quadratic moments does not seem of any but a purely mathematical interest, and one rather grudges the page devoted to it in this brief chapter.

After a chapter on instantaneous motions, we are led on to the equations of motion of a rigid body, with reference to a system of moving axes, which finally, when the body turns about a fixed point, is identified with the principal axes of moment of inertia passing through the fixed point. In connection with the equations of motion for this case—Euler's equations—which are of the form

$$A\dot{p}-(B-C)qr=L,$$

the usual statement is made that the equations may be written:

$$A\dot{p}=L+(B-C)qr,$$

and that then the quantities typified by $(B-C)qr$ are referred to as the components of a "centrifugal couple." This couple is quite rightly designated "fictitious"; but, apart from the lack of reality which afflicts it, its introduction seems undesirable. To speak of these quantities as "centrifugal couples" seems a perfectly artificial, unphysical, and almost unintelligible mode of regarding the matter. Centrifugal couples are worse than centrifugal forces, those unrealities against which Tait used to fulminate vehemently.

What one wants to convince the student here is that $A\dot{p}$ is not the whole rate of growth of angular momentum about the fixed axis, with which the principal axis at the instant coincides, and must be supplemented by the rate of growth $-(B-C)qr$ which exists in consequence of the motion of the axes. The whole rate of growth is $A\dot{p}-(B-C)qr$, and there is no ray of light thrown on the subject by carrying the second part from its proper place to the other side of the equation and calling it a couple. The use of "centrifugal couples" is justifiable only when the action of, or reaction on, an axis is in question.

We hope that we shall not be misunderstood. Of course, Prof. Lamb is perfectly aware of all this; but our point is that, as the question is one of getting correct ideas into the minds of students, this venerable and "Through the Looking-Glass" mode of referring to these terms would be better forgotten. Students, and even some writers, are all too prone to suppose that the component growths of angular momentum are $A\dot{p}$, $B\dot{q}$, $C\dot{r}$, and the equations are naïvely written as $A\dot{p}=L$, etc.

It is, by the way, very important, and very easy, to take the terms $A\dot{p}$, $-Bqr$, Cqr, and show how *each* of them arises.

We miss here what is certainly very instructive: the application of the hodograph to the motion of a rigid body—for example, a top. A sequence of vectors all drawn from a point O is erected in space to represent the successive values of the resultant angular momentum. The curve in space on which lie their extremities is the hodograph for the rigid body motion, and the resultant couple at each instant is represented by the velocity of a point which moves so that it is always at the extremity of the vector which at the instant represents the angular momentum.

In connection with holonomous systems, the only reference is to Hertz, though the fact that there are systems which are not holonomous for which Lagrange's dynamical method "fails," and which require special treatment, was pointed out by Ferrers long before Hertz's treatise appeared.

The paper of Ferrers (*Q.J.M.*, vol. xii., 1873) appeared six years after the publication of Thomson and Tait's "Natural Philosophy," but it is curious that there is not in the second edition (1883) of that treatise any hint of the existence of the peculiar systems of which Ferrers gave examples. In his review of the second edition of the "Natural Philosophy" (NATURE, vol. xx., 1879), Clerk-Maxwell, in his own inimitable way, directed attention to the introduction in that work of the method of Lagrange. "The two northern wizards were the first who, without compunction or dread, uttered in their mother tongue the true and proper names of those dynamical concepts which the magicians of old were wont to invoke only by the aid of muttered symbols or inarticulate equations." The spell of the "northern wizards" was not free from defect, but either their good fortune or their instinct preserved them from the examples in which the use of an incantation insufficiently guarded in its terms might have led to disaster.

This has not been the fate of every wielder of the magic wand of Lagrange. In the first issue, about twenty years ago, of an important treatise on "Rational Mechanics" a discussion of the motion of a coin rolling and spinning on a horizontal table appeared, in which the method of Lagrange was used with erroneous results. The error led the distinguished author to the invention of a new method, in which a set of general dynamical equations, which could be used instead of those of Lagrange, and were applicable in all cases, was set up. The error thus had the fortunate effect of enriching dynamical science. It is not, alas! the fate of all who make mistakes to rise on the stepping-stones of their errors to higher and better things.

In our opinion, recourse is had to the method of Lagrange in far too many cases. The student flies to it on the appearance of the least difficulty. A proper training in dynamics, which should be experimental as well as mathematical, would give students the power of solving problems of all kinds by the direct application of first principles. The use of Lagrange's equations does not develop this—indeed, it has a directly contrary effect. In this power the dynamical students and graduates of our universities are sadly deficient.

A good account of Lagrange's method is followed in Prof. Lamb's book by an exposition of Hamilton's dynamical method, and this in its turn leads to Jacobi's discussion of the integration of Hamilton's canonical equations by means of the complete integral of Hamilton's partial differential equation fulfilled by his so-called principal function S. The corresponding function S' connected with S by the relation $S+S'=\Sigma(pq)$ does not seem to be mentioned. A partial differential equation similar to, and yet curiously different from, that for S also holds for it. S is a function of the qs, t, and as many constants, which depend on the initial co-ordinates of the system, as there are independent co-ordinates; S' is a function of the ps, t, and the same number of constants as before, which, however, depend on the initial motion.

One or two examples of the solution of these partial differential equations—for example, Jacobi's discussion of the elliptic motion of a planet referred to three co-ordinates—would have added to the interest of what is in itself a very interesting chapter of an excedingly interesting book.

A. GRAY.

Maya Civilisation.

The Inscriptions at Copan. By Sylvanus Griswold Morley. (Publication No. 219.) Pp. xii+643+33 plates. (Washington: The Carnegie Institution of Washington, 1920.)

IN this large quarto volume of more than six hundred pages, efficiently illustrated, Dr. S. G. Morley has produced a work which may justly be regarded as of the highest importance. It is necessary to enforce this statement, almost with a feeling of shame, because there are so few individuals in this country who have the faintest idea what enormous strides have been made in the elucidation of Central American archæological problems since our own countryman, Dr. Maudslay, published the results of his explorations in a series of volumes, which Dr. Morley generously, but no less justly, describes as "easily the most important field contribution to Maya archæology." Those volumes might have been expected to give a lead to British archæologists and explorers; as a matter of fact, not only did no one appear in this country to carry on Maudslay's work, but the fine series of moulds of the principal Central American carvings, which he made at the cost of enormous labour and expense, lie buried in the cellars of the Victoria and Albert Museum, and not even an approximately representative series of casts taken from them is available to British students.

It follows that such a work as this is almost the despair of the reviewer. Most people have heard of the Aztec, but the earlier Maya civilisation is familiar to few even by name. Yet the Maya had evolved a remarkably fine art, an elaborate hieroglyphic script, and a very highly developed calendrical system long before the first manifestations of culture made their appearance in the Valley of Mexico. To render a full appreciation and critique of Dr. Morley's book intelligible to the general reader, it would be necessary to write an introduction to Central American archæology; to deal with it from the purely scientific point of view is impracticable within the limits of an ordinary review, so many and important are the problems which the author raises. It is possible, therefore, to give only the merest sketch of the subject-matter, and to add a few remarks on the author's method of handling his material.

The early Maya settlements are found scattered throughout the forested region of Chiapas, eastern Guatemala, western British Honduras, and northern Honduras. It is clear that they had already been abandoned and veiled in thick jungle before the arrival of the Spaniards. The group with which Dr. Morley deals is situated in Honduras, in the valley of the Copan River, and covers a site of 30–35 sq. km. The ruins consist of sculptured monolithic *stelae* and "altars," temples, pyramids, "plazas," and a great complex, known as the "main structure," which exhibits evident signs of growth by accretion through many years. The site, apart from its architectural and artistic importance, is of paramount interest from the fact that it includes by far the greatest number of dated inscriptions, about 40 per cent. of those recorded for the whole of the Maya area, indicating that the "city" was in continuous occupation for about 350 years. It is the inscriptions which constitute the principal theme of the book, and the author has dealt faithfully with every inscribed monument, not only discussing the content of every inscription, but also giving a bibliography of each.

With regard to these inscriptions a word of explanation is necessary. The only portions which can be read with certainty are those connected with the Maya system of reckoning time. As much as 50 per cent. of the entire *corpus* of these inscriptions deals with calculations relative to the calendar; the rest are probably religious, with, perhaps, a small proportion of what may be historical data. But, while dated monuments may thus be arranged in sequence according to Maya chronology, no indisputable method has yet been reached of correlating that chronology with European time. Dr. Morley, in a very scholarly appendix, makes the attempt. His views are of particular interest to the present reviewer, who, some years ago, was rash enough to put forward a scheme on similar lines, producing, however, different results. At the same time, Mr. Bowditch, one of the greatest pioneers in the interpretation of Maya glyphs, working on other evidence, came to the same conclusion. Dr. Morley's theory would make the Copan monuments date from about the close of the second century A.D. to the early part of the sixth century, about 250 years later than the dating of Mr. Bowditch and the reviewer. Dr. Morley's argument does not carry absolute conviction to the reviewer; but discussion is perhaps unnecessary. The author gives good *prima facie* evidence that a certain group of glyphs, which accompanies the so-called "initial dates," relates to eclipses of the sun and moon. With this lead these glyphs should soon be deciphered, and the question will then be capable of proof on astronomical grounds. In this connection it might be mentioned that Dr. Morley has apparently overlooked, in his otherwise excellent bibliography, two papers by Mr. Richard C. E. Long dealing with the correlation of Maya and European time, which were published in *Man* during 1918.

The origin of the Maya civilisation is also closely argued by Dr. Morley in a well-written appendix, but here he lays himself open to criticism. His theory that the Maya came from the region of the Panuco Valley in the north is well argued on general grounds, but he certainly lays too much stress on dates which have been found on two small objects—the Tuxtla statuette and the Leyden plate. Considering the ritual and mythological importance of certain calendrical dates in the Maya religious system, it is impossible to regard specimens of this class as belonging to the same category as monuments which are so obviously commemorative as *stelae*, altars, and the like. The Tuxtla statuette, which bears almost the earliest date known in Maya chronology, he accepts as belonging to the area where it was found—*i.e.* considerably to the north of the "classical" Maya area—in spite of the fact that the glyphs are carved in the same style as the Dresden manuscript, which is recognised as belonging to a later period than the Copan monuments. The Leyden plate, which is carved in the earlier style, and was found in the southern Maya region, he assumes, is a specimen which has "wandered"—a hypothesis which he dismisses in connection with the Tuxtla statuette. This savours of "having it both ways," and his theory would have gained strength had he admitted that portable objects such as these are really *hors concours* as regards local dating.

One mistake—and that really of relative insignificance—may be recorded. Dr. Morley states that the few original monuments brought from

Copan to England by Maudslay, such as Altar R and part of the frieze of Temple II., are in the Victoria and Albert Museum. As a matter of fact, all the original sculptures collected by Maudslay were transferred to the British Museum shortly after their temporary deposition at South Kensington.

In conclusion, Dr. Morley's work is scientific and scholarly. As a scientific man and a scholar he aimed at perfection; he has achieved a landmark. Can higher praise be given?

T. A. JOYCE.

The History of Determinants.

The Theory of Determinants in the Historical Order of Development. By Sir Thomas Muir. Vol. iii., *The Period* 1861 *to* 1880. Pp. xxvi+503. (London: Macmillan and Co., Ltd., 1920.) Price 35*s*. net.

THE period covered by this volume is perhaps the most important in the history of the subject. During that time three important branches of pure mathematics attained vast dimensions—invariant-theory, analytical geometry, and the general theory of algebraic numbers. In each of these, familiarity with determinants and their manipulation is essential, so a great many students mastered the determinant calculus, and applied it to a variety of problems. Incidentally, the properties of determinants aroused interest for their own sake; numerous papers dealing with them were published, and, above all, several treatises on the subject made their appearance, in which a compact notation replaced all the old cumbersome symbols, and practically all the theorems of the determinant calculus proper were expounded in a simple and orderly way.

What we may call the derivative part of the theory consists mainly of classifying determinants of special types. Thus in the present volume we have separate chapters on axisymmetric determinants, symmetric determinants, alternants, recurrents, Wronskians, Jacobians, etc. (sixteen chapters or so). Broadly speaking, these types come from two sources—either as the outcome of a particular research, not primarily concerned with determinants (thus continuants arose from the theory of continued fractions); or else from intrinsic characters belonging to the array from which the determinant is formed, as in the case of symmetric determinants. Of course, any special type of determinant can be specified *per se*; we are thinking rather of the way in which the discussion of particular types actually originated. A remarkable example is Smith's arithmetical determinant (p. 116), of n rows and columns, the value of which is the product $\phi(1).\phi(2) \ldots \phi(n)$, where $\phi(m)$ means the "totient" of m—namely, the number of integers prime to m and not exceeding it.

In a book such as this, one feature is almost sure to present itself. We shall find some excellent work unaccountably neglected, and results of first-rate importance only becoming generally known and appreciated after re-discovery, when their original authors are dead. The cases in this volume which strike the attention are those of Trudi and Reiss. Reiss's work on compound determinants goes back as far as 1867; the analysis of it on pp. 181–90 (in modern notation) shows its importance, and is worth study, because the theory of compound determinants is perhaps the one part of general determinant-calculus not yet fully reduced to its complete and simplest form.

In many applications the rank and elementary divisors of a determinant (or matrix) are of primary importance. The elementary divisors of an array depend upon the arithmetical or algebraical character of the field to which the elements of the array belong. Consequently, the determination of them does not properly belong to determinant-theory; on the other hand, the rank of an array is immediately calculable, on the assumption that we can calculate the "value" of any minor determinant, or, at any rate, decide whether it is or is not zero. It must often have been difficult for the author to decide when a theorem in matrices should or should not be considered one relating to determinants. Rank is referred to several times; apparently theorems about elementary divisors have been omitted. In the case when the elements of an array are ordinary integers it is clear from Smith's paper on linear indeterminate equations and congruences (1861) that he was then perfectly familiar with the existence and properties of elementary divisors; to that extent he anticipated the theory of Weierstrass, Frobenius, and others.

Opinions may differ about Sir T. Muir's choice of a subject on which to bestow his labour; some readers may regret that he did not select a branch of mathematics of a less circumscribed and subsidiary kind than determinant-theory undoubtedly is. But all will agree in admiring the ability and impartiality with which this labour of love has been accomplished, and rejoice to know that the fourth and final volume is nearly complete in manuscript. Histories of other branches of mathematics are badly wanted, and this work is a model of what such histories ought to be.

G. B. M.

Science and Farming.

(1) *The Small Farm and its Management.* By Prof. James Long. Second edition. Pp. 328. (London: John Murray, 1920.) Price 7*s*. 6*d*. net.

(2) *Farm Management.* By J. H. Arnold. Pp. vii+243. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1919.) Price 7*s*. 6*d*. net.

(3) *Types and Breeds of Farm Animals.* By Prof. C. S. Plumb. Revised edition. (Country Life Education Series.) Pp. viii+820. (Boston and London: Ginn and Co., 1920.) Price 16*s*. 6*d*. net.

(1) PROF. LONG is a well-known believer in small farms, and has written much to help the men who embark on such enterprises. In the present volume he brings together in convenient form a great deal of the information which the small farmer ought to possess if he is to make his work a success. At the outset he disclaims any intention of deluding his readers into the belief that fortune awaits the small holder. The 20-acre farm, he says quite frankly, will not bring much money, though it will provide a healthy occupation full of interest to those who really do their best. In the main, the scheme proposed is the production of finished products—milk, pork, poultry, or mutton. Corn scarcely enters into consideration excepting only to provide oats for the farm stock.

The information given is useful so far as it goes, but we should like to have seen some references to other books which would give fuller information on specific points. The idea of rural libraries is growing, and the present deficiency may not always exist. On such points as the feeding of animals an intelligent man might easily like more information; the latest author quoted is Wolff, and no reference is given to Dr. Goodwin's translation of Kellner's book.

Similarly, reference might have been made to the system of advisory officers now established over the country, whose function it is to deal with the questions an intelligent man asks, but which no book ever seems to answer. In spite of these minor defects, however, the smallholder will find this a useful book, both before and after he enters his farm.

(2) Mr. Arnold's is a different type of book; it deals with the principles of farm management so far as they have been enunciated, and though it is only small and printed in large type, it contains much that will interest the farmer as well as the student of agriculture. It is American; we know of no corresponding English book; and the figures quoted all refer to the pre-war period. An inquiry is recorded as to the rate of interest earned on farms in three States of the corn belt: for "landlord's" expenditure (which includes much of our "farmer's" expenditure) the annual return was 3½ per cent., and in an exceptionally good region 5⅛ per cent., after allowing 800 dollars for management salary; this, the author states, "probably represents about what the best general farms are doing." An interesting historical summary traces the development of American agriculture during the last 300 years, and shows that American farm practice is largely derived from English agriculture, modified, however, by the experience of the Indians. Livestock, poultry (excepting turkeys), most of the common grains, vegetables, grasses, and legumes all came from England, as also did the principles underlying the cultivation of the soil and the rotation of crops. It would be interesting to work out the interrelationships of British and American agriculture, for, if American agriculture developed from ours, British agriculture in the last twenty years owes a great deal to America.

(3) Prof. Plumb's book on "Types and Breeds of Farm Animals"—also American—brings out prominently the part played by the British Isles in the evolution of modern types of farm animals; the author draws a map showing the areas in which no fewer than twenty-eight important types were first bred. These have now gone out to all parts of the world, but buyers still come here to replenish their stocks.

The book gives probably the best account published of modern farm animals, and there are good illustrations of many of the best examples to be found to-day. Another very interesting feature is the history of the families which the author has diligently worked out; the leading families in America date back to about 1880, although in England they are much older. Pedigree is more important to a high-class cow than to a human being, and no animal without a clear record can enter the highest bovine circles. The best foreign buyers insist on a pedigree going back a good many years—a great advantage to the English breeder. But the records of the animals described by the author in America show that the American stockman is doing great things, while the book itself proves that the younger generation of American agricultural experts is thoroughly familiar with the characteristics of the breeds and with the uses to which they can be put. It is a book to make the British agricultural lecturer think.

E. J. R.

Our Bookshelf.

Animal Ingenuity of To-day. By C. A. Ealand. Pp. 313. (London: Seeley, Service, and Co., Ltd., 1921.) Price 7*s.* 6*d.* net.

MR. EALAND describes in a lively way the ingenious or apparently ingenious behaviour of a great variety of animals, and we strongly recommend his book of wonders to the young in years and to the young in spirit. It deals with such matters as the humble-bee's nest, the wasp that uses a little pebble for beating down the soil closing the entrance to its burrow, the animated honey-pots of the honey-ants, the aquatic beetle that taps the water-lily's store of air, the male water-bug called Zaitha, which is made to carry the eggs, and the male cuckoo's abetting of his "paramour's" foisting of her egg into another bird's nest, for he takes advantage of his likeness to a sparrowhawk to distract attention from the "nefarious" deed. This case of "mimicry" takes our breath away, and we must rest awhile. But Mr. Ealand's book is extraordinarily interesting, though he is sometimes not critical enough. There is a good account of birds' nests and eggs, though we do not believe in the woodcock's "all-too-conspicuous eggs." With the usual withered leaves around them they do not seem to us to be conspicuous at all. Of courtships, migrations, modes of hunting, engineering triumphs, parental care, and of the whole gamut of animal behaviour, Mr. Ealand has vivid illustrations to give, and we should like it all, both old and new, without reserve, if he were a little more careful. Let us give one example. As he himself says: "Friendship between a crab and a pond-mussel seems to savour of the improbable," and we should think it did, for, friendship apart, the pea-crab in question lives in the sea. We have referred to credulity and inaccuracy, but we must make another criticism of what, after all, we regard as a wholesome book. Is it right and proper to quote long passages within inverted commas without telling us who wrote them? The illustrations of the book are very clever.

Prospector's Field-book and Guide. By H. S. Osborn. Ninth edition, revised and enlarged by M. W. von Bernewitz. Pp. xiii+364. (London: Hodder and Stoughton, Ltd., 1920.) Price 12*s.* 6*d.* net.

A QUANTITY of new material has been added to this handbook since the last edition was published in 1910. Some of it, particularly those portions referring to the description of ore deposits and ore-testing, has been drawn from the bulletins of the United States Geological Survey and the Bureau of Mines, and various publications of schools of mines and the technical Press. Other additions which have been made are lists of outfits suitable for prospecting, fresh field tests, notes on sampling, and a new chapter dealing with alloy minerals. In face of the claim that the new edition is thoroughly up-to-date, it is curious to find "chloride of formyl" given in the appendix as the chemical name for chloroform. A glossary of more than twenty pages gives brief explanations of the technical terms in use, and, in addition, a very full index is provided.

Dictionary of Explosives. By A. Marshall. Pp. xiv+159. (London: J. and A. Churchill, 1920.) Price 15*s.* net.

THIS book is essentially a work of reference for the specialist in explosives, and has little interest for the general reader. It consists of three sections. The main section is descriptive, and arranged alphabetically. This is prefaced by a list of explosives classified according to the uses for which they are intended, and followed by a list of the separate ingredients showing the explosives in which each is used.

In the dictionary the composition and some of the properties of a large number of explosives are given, including many of foreign origin, but only those explosives are dealt with which are, or have been, in practical use in the industries. It is easy to see that the author has been handicapped by the reticence of explosives manufacturers with regard to the composition of their products, only about half the authorised explosives mentioned in the 1914 Annual Report of H.M. Inspectors of Explosives, for instance, being described. For the same reason, many of the descriptions lack the detail desirable in a work of this kind.

A considerable amount of useful and accurate information is, however, presented in a compact and handy form. The book is well printed and free from typographical errors.

W. L. TURNER.

Report on the Quantum Theory of Spectra. By Dr. L. Silberstein. Pp. iv+42. (London: Adam Hilger, Ltd., 1920.) Price 5*s.* net.

THIS small and unpretentious work is one of great value. Many important developments in the application of the quantum theory to spectra, especially to the fine structure of spectrum lines, have taken place during the last few years, and these are almost entirely due to workers in other countries. The literature of the subject is very inaccessible to English readers, who find it difficult to obtain any real idea of the fundamental advances which have been made, or of the logical suppositions on which such advances rest. Dr. Silberstein would have done good service if he had only collected together the original papers, in translation, as they stand. He has, however, done much more. The matter is presented as an orderly scheme, and great discrimination has been shown, so that there is nothing of real importance omitted from the work. At the same time, the author has modified the original treatment in many respects, and apparently always to its advantage. The work is especially noteworthy in that it gives a clear view of the problems which still await solution. We can give nothing but praise to this book, and can recommend it without reserve to those who are anxious to have a simple and not very mathematical account of a subject which is now fundamental in physical theory.

Smithsonian Physical Tables. Seventh revised edition. Prepared by F. E. Fowle. Pp. xlvi+450. (Washington: Smithsonian Institution, 1920.) Price 18*s*. net.

SINCE the sixth edition of this standard volume of tables was reviewed in NATURE for July 5, 1915, extensive changes have been made, in the form of new data on both new and old topics. The volume has grown to 450 pages, and the number of tables given from 409 to 579. The new tables include useful material dealing with astrophysics, meteorology, geochemistry, atomic and molecular data, colloids, photography, etc. A great improvement is the renumbering of the pages; in the sixth and fifth editions new matter was inserted without altering the paging, with the result that there was no logical sequence of tables. This fault has now been rectified, and the tables have been arranged in order according to subject. The volume can be obtained from the London agents for the Smithsonian Institution, Messrs. W. Wesley and Son, 28 Essex Street, Strand, W.C.2.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Late Srinivasa Ramanujan.

IN the notice contributed to the issue of NATURE for June 17 last, Prof. Hardy was unable to give any account of the late Srinivasa Ramanujan's early life, and made no attempt to describe his appearance or character. The June number of the Journal of the Indian Mathematical Society has memorial articles by Prof. P. V. Seshu Aiyar, of Madras, and Dewan Bahadur Ramachandra Rao, and the first of these gives biographical details that have not hitherto been published in England.

Ramanujan was born at Erode on December 22, 1887.[1] His mother, a shrewd and cultured lady who is still alive, was the daughter of a Government official at Erode, his father a cloth-merchants' accountant at Kumbakonam, and it was in the latter town that his boyhood was spent. As is usual with Brahmin boys, he was sent to school at the age of five; before he was seven he was transferred to the Town High School, and there he remained until 1904, leading an inactive life and building an astounding edifice of analytical knowledge and discovery on the foundation of Carr's "Synopsis of Pure Mathematics," the only book on higher mathematics to which he had access. Having matriculated already in 1903, he went from the Town School to the Government College at Kumbakonam, but in January, 1905, his progress was stopped, and a scholarship on which he was dependent forfeited, owing to a weakness in English of which those who recall his fluency and the range of his vocabulary in later life will be surprised to learn.

Of Ramanujan's next few years no clear account has come to my notice. After a stay at Vizagapatam, he joined the Pachaiyappa's College at Madras, but, failing in his first examination, he gave up the idea of taking a university course. A nomadic period, during which his own researches progressed, came to an end in the summer of 1909, when he married and returned to Madras in search of permanent employment. There Prof. Seshu Aiyar, who had seen something of him at Kumbakonam in 1904, gave him a letter of introduction to Mr. Ramachandra Rao, at that time district collector at Nellore. Possibly Ramanujan was too timid to make direct use of the letter; Mr. Rao's story follows in his own words:—

"Several years ago, a nephew of mine, perfectly innocent of mathematical knowledge, spoke to me: 'Uncle, I have a visitor who talks of mathematics. I do not understand him. Can you see if there is anything in his talk?' And in the plenitude of my mathematical wisdom, I condescended to permit Ramanujan to walk into my presence. A short, uncouth figure, stout, unshaved, not over-clean, with one conspicuous feature—shining eyes—walked in, with a frayed note-book under his arm. . . . He was miserably poor. He had run away from Kumbakonam to get leisure in Madras to pursue his studies. He never craved for any distinction. He wanted leisure; in other words, simple food to be provided for him without exertion on his part, and that he should be allowed to dream on.

"He opened his note-book and began to explain some of his discoveries. I saw quite at once that there was something out of the way, but my knowledge did not permit me to judge whether he talked sense or nonsense. Suspending judgment, I asked him to come over again. And he did. And then he had gauged my ignorance and showed me some of his simpler results. These transcended existing books, and I had no doubt that he was a remarkable man. Then step by step he led me to elliptic integrals, and hypergeometric series, and at last his theory of divergent series, not yet announced to the world, converted me. I asked him what he wanted. He said he just wanted a pittance to live on so that he might pursue his researches. It is a matter of considerable pride to me that I was in some way useful to this remarkable genius in his earlier days. In a year's time, I introduced him to Sir Francis Spring (the president of the Madras Port Trust), who gave him a sinecure post in his office."

The last two sentences conceal that, throughout the interval of a year, not only was Mr. Rao trying to find some scholarship for which Ramanujan's original work might qualify him in spite of failure in examinations, but he was also maintaining Ramanujan in Madras at his own expense.

At the Port Trust Ramanujan remained until Dr. G. T. Walker, on an official visit to Madras, was made acquainted with his history, and joined forces with Sir Francis Spring. Their combined attack on the University and the Government of Madras resulted in the creation of a research studentship, which was of sufficient value to set him wholly free, and secured him access to the lectures and the library of the university; he was in possession of this studentship when I met him in 1914.

To Prof. Hardy's account of his correspondence and my intervention I have little to add. My task was an easier one than I anticipated. From the Government and the University of Madras I had every encouragement. On the other hand, Ramanujan was ready to put complete confidence in me simply because to him and his friends I came from outside the official machine. The only cold water was thrown

[1] This is the year given by Seshu Aiyar, and the date is consistent with the undisputed statements that Ramanujan was twenty-six when he came to England and thirty-two when he died; I have no doubt that the date 1888 commonly given is due to a natural misinference from these last figures.

from the India Office in London, but my efforts had succeeded before this reached Madras.

Throughout his life Ramanujan kept religiously to a diet of vegetables, fruit, and rice, and in England, outside his own rooms, food and clothing were a continual trial to him. I have known him ask with unaffected apologies if he might make his meal of bread and jam because the vegetables offered to him were novel and unpalatable, and with a pathetic confidence he has appealed to me for advice under the discomforts of shoes and trousers. His figure was short, and until his health gave way it was stout. His skin, never of the darkest, grew paler during his stay in England. His head gave the impression, which photographs show to have been false, of broadening below the ears, which were small. His face was clean-shaven, with a broad nose and a high forehead, and always his shining eyes were the conspicuous feature that Mr. Rao observed them to be in 1910.

Ramanujan walked stiffly, with head erect, and his arms, unless he was talking, held clear of his body, with hands open and palms downward. In conversation he became animated, and gesticulated vividly with his slender fingers. He had a fund of stories, and such was his enjoyment in telling a joke that often his words struggled incomprehensible through the laughter with which he anticipated the climax of a narrative. He had serious interests outside mathematics; he was always ready to discuss whatever in philosophy or politics had last caught his attention, and Indians speak with admiration of a mysticism of which his English friends understood little.

Perfect in manners, simple in manner, resigned in trouble and unspoilt by renown, grateful to a fault and devoted beyond measure to his friends, Ramanujan was a lovable man as well as a great mathematician. By his death I have suffered a personal loss, but I do not feel that his coming to England is to be regretted even for his own sake. Prof. Hardy speaks of disaster because of the hopes he entertained. If he pictures Ramanujan as he might have been throughout a long life, tormented by a lonely genius, unable to establish effective contact with any mathematicians of his own class, wasted in the study of problems elsewhere solved, Prof. Hardy must agree that the tragedy averted was the greater. Shortly before he left England, at a time of great depression, Ramanujan told me that he never doubted that he did well to come, and I believe that he would have chosen as he did in Madras in 1914 even had he known that the choice was the choice of Achilles.

E. H. NEVILLE.

University College, Reading, December 7.

The Mechanics of Solidity.

THE letters under this title from Mr. R. G. Durrant, Mr. V. T. Saunders, and Dr. H. S. Allen (NATURE, December 2 and 23 and January 6) are very interesting and suggestive, but melting points are of little value in discriminating between the hard and soft varieties of the same steel, and molecular weights, volumes, and frequencies have not yet any very definite significance in relation to solid metallic mixtures. My initial proposal that certain simple measurements might with advantage be substituted for the complicated tests now used by engineers and metallurgists was a "practical," if myopic, one; it has evidently been misunderstood, so perhaps I may be allowed to state the case in greater detail.

By "solidity" I meant to imply all the properties covered by the adjectives strong, elastic, stiff, flabby, tough, hard, mild, brittle, and many others. Solidity may eventually be specified in terms of atoms and molecules, but the specification would be very complicated, and I cannot at present "take sanctuary among the atomists"; solidity may be referred to its origins or to its manifestations, and for the moment the latter course seems to be the only practicable one. Solidity may be analysed in various ways, but Hertz has explained the meaning of "strength" very clearly, and it is convenient to take strength as the starting point; solidity seems to comprise elasticity, strength, and something more, namely, the variation of elasticity and strength with deformation. Isotropic solidity appears to be a continuum which fades into fluidity; it would be very desirable to know how many dimensions define this continuum, but the problem of mechanical testing is rather simpler, viz. How many dimensions are important, and what is the best way to measure them?

For the convenience of readers of NATURE who are unfamiliar with current engineering practice I may refer to the recent report of the Steel Research Committee of the Institution of Automobile Engineers; this, of course, is primarily a report on certain metals, but incidentally it serves as a report on the tests employed. The procedure is as follows: Test pieces are cut to three standard shapes and broken under prescribed conditions; four different measurements are made on the first piece and one measurement on the second and third pieces. The second and third tests are each repeated three times, and Brinell measurements are made on all test pieces. The report represents practice of a very high standard, and the foregoing programme is carried out thrice for each of some two hundred mechanical varieties of twenty chemically distinct steels; the report records about ten thousand measurements in all, each of them involving considerable care and labour. I feel sure the committee would endorse my view that in certain tests the concordance of nine individual measurements leaves a great deal to be desired; whatever these tests may determine, they do not determine anything very accurately.

To obviate all possibility of misconception, I should state the proposed alternative plainly. Six simple mechanical properties of a metal—density, two elasticities, and their temperature coefficients—can be measured fairly easily and with some precision; the temperature coefficient of intrinsic energy makes a doubtful seventh. The connection between these properties and practical engineering is admittedly obscure, but in the writer's limited experience this is true also of some of the other tests. None of the six properties referred to are customarily measured, but the single one that is well known—the thermal coefficient of density—bears a decided general resemblance to a strength, the particular strength to which Hertz has appropriated the word "hardness." My suggestion is that these six properties, and possibly others, would be worth investigating, and that some of them may prove convenient indicators of mechanical consistency; they would certainly serve as indicators of uniformity, and it may be doubted whether the other tests do much more.

Both Mr. Durrant and Mr. Saunders refer to the question of definitions, and these are certainly required for many of the attributes of solidity; hardness, however, appears to be an exception, and has been defined by Locke, Hertz, and Clerk-Maxwell. A definition established in the seventeenth century and supported by such high authorities cannot lightly be set aside; it seems that Mr. Saunders is right, and that "Brinell hardness" is not hardness. Verbal difficulties of this kind beget confusion, but, as Locke says: "Vague and insignificant forms of speech and abuse of language have so long passed for mysteries of science; and hard and misapplied words, with little or no meaning, have, by prescription, such a right to be mistaken for deep learning and height of speculation, that it will not be easy to persuade, either those who speak or those who hear them, that they are but the covers of ignorance and hindrance of true knowledge." J. INNES.

12 Edward's Road, Whitley Bay, Northumberland, January 4.

Stellar Development in Relation to Michelson's Measurement of the Diameter of Betelgeux.

ABOUT thirty-five years ago Sir Norman Lockyer held that certain of the reddish stars are probably in an early stage of development. It was given out yesterday in Press dispatches from Chicago that Prof. Michelson had announced to the American Physical Society and the American Association for the Advancement of Science that the experiments with the Mount Wilson 8-ft. reflector at Pasadena, California, had enabled him successfully to measure the diameter of α Orionis by interference methods, and that the diameter is about 300,000,000 miles, or approximately three hundred times that of our sun. The volume of Betelgeux is therefore about 27,000,000 times that of the sun; so that, if concentric with the sun, the surface of Betelgeux would extend about to the orbit of Venus.

Now Betelgeux is a single star, and the mass, therefore, is not definitely known; yet if the mass be not immensely larger than that of the sun we shall have to conclude that the density is slight. Hence this red star is in an early stage of development, which confirms Lockyer's views first put forth about 1886. If we make the density equal to that of our sun, Betelgeux could not fill the orbit of Venus without giving the star 27,000,000 times the solar mass, which is quite inadmissible.

Dr. Elkin's Cape heliometer measures made the parallax of Betelgeux 0·023″ and of Sirius 0·37″, so that Betelgeux is only sixteen times more remote than Sirius; and if we neglect a slight difference in magnitude, largely due to colour, we may conclude that Betelgeux gives about 256 times the radiation of Sirius, which is itself ten-thousandfold more luminous than our sun. Accordingly, Betelgeux gives about 2,560,000 times the sun's light. Now with any admissible mass of Betelgeux this immense luminosity indicates an early stage of development, corresponding to the large absolute diameter found by Michelson. T. J. J. SEE.

Naval Observatory, Mare Island, California, December 30.

Heredity and Variation.

IN a brief criticism of Sir Archdall Reid's letter to NATURE (November 25, p. 405) in which he sought to attach new meanings to certain well-recognised biological terms, I pointed out (NATURE, December 2, p. 440) that if his contention that all characters are both innate and acquired in exactly the same sense and degree is true, then it would follow that all variations are also of one type, while experimental biologists are universally agreed that this is not the case. At least two categories of variations are postulated, whether they be called blastogenic and somatogenic, germinal and somatic, mutations and fluctuations, genotypes and phenotypes, innate and acquired, karyogenetic and cytogenetic, or by any other terms which contrast an inherited and a non-inherited departure from the parental type.

Yet Sir Archdall Reid's only attempt to answer my criticism—that the universally admitted existence of two types of variations undermines his whole position—is the very weak one of quoting Darwin's tentative theory of pangenesis, which no modern biologist would consider seriously as an explanation of heredity, variation, or anything else. He says (NATURE, January 6, p. 596): "If we believe with Darwin in his theory of pangenesis that the parts of the child are derived from the similar parts of the parent . . . the distinction between variations and modifications vanishes." But we do not believe anything of the kind. The advance of knowledge made any such belief impossible a generation ago. Even Sir Archdall Reid himself admits this when he says later in the same letter (p. 598) that "Darwin . . . went hopelessly wrong . . . in his theory of pangenesis"! Why, then, did he quote it as a reply to my criticism?

This is only one, but it appears to me to be the most fundamental, of the many contradictions in which Sir Archdall Reid has landed himself in his attempt to remodel the usage of well-established terms to his own liking. R. RUGGLES GATES.

King's College, Strand, W.C.2, January 15.

The Mild Weather.

A SPELL of mild weather set in shortly before Christmas and continued until the second week of January. It followed a sharp touch of frost, when the sheltered thermometer at Greenwich registered 16° on December 13, and for two consecutive days, December 12 and 13, the temperature remained below the freezing point, whilst for ten consecutive days the thermometer did not rise to 40°. A few facts relative to the mild spell may be of interest.

Greenwich temperatures are used throughout; they refer to the civil day, commencing at midnight, and naturally differ at times from the ordinary meteorological day readings ending at some hour between 7 and 9 a.m. The results used are absolutely comparable.

The period dealt with is from December 21 to January 10, twenty-one consecutive days. This period for 1920–21 was warmer than any corresponding period in the last eighty years—since 1841. The mean maximum temperature, the mean minimum temperature, and the mean temperature obtained from the mean of maximum and minimum were all the highest. These three readings for the 21-day period in 1920–21 are: 52·0°, 43·4°, and 47·7° F. The next highest means, for 1872–73, are 51·2°, 42·8°, and 47·0°, followed by 1915–16 with 50·9°, 41·9°, and 46·4°, and by 1852–53 with 51·3°, 40·7°, and 46·0°.

Dealing with the first ten days of January this year, they are the warmest on record for this period for eighty years, with the mean (mean maximum and minimum) 47·8°, followed by 1873 and 1916 with 46·8°, and by 1853 with 46·0°.

Considering the days with a temperature of 50° or above for the 21-day period, December 21 to January 10, there were 17 days in 1852–53, 15 in 1872–73, 14 in 1920–21, and 13 in 1876–77. The absolute maximum temperature in the recent warm period rose to 56° on three days, and in the past there has been no temperature higher than 57°.

The mild weather we have just passed through had ten nights with the minimum temperature at 45° or above, which is more than in any corresponding period since 1841, and in all there were previously only two periods with more than five such warm nights.

The mean temperature for the twenty-one days to January 10 this year is about 10° warmer than the normal. CHAS. HARDING.

65 Holmewood Gardens, S.W.2, January 15.

Nature of Vowel Sounds.

By Prof. E. W. Scripture.

II.

In a preceding paper (Nature, January 13, p. 632) it was explained that the analysis of vowel curves showed (1) that the fundamental, or voice tone, must consist of a series of puffs, and not of smooth vibrations; and (2) that the overtones, or the specific vowel tones, must be quite independent of the fundamental—that is, they can just as well be inharmonic as harmonic to it.

The Manufacture of Vowels.

For the manufacture of vowels Helmholtz used tuning-forks that gave smooth vibrations and not puffs; moreover, the only overtones tried were harmonic to the fundamental. Some years ago I made an attempt to manufacture vowels on the principles discovered by the analysis of vowel curves.

The fundamental was produced by a puff siren (Fig. 7) similar to the familiar one of Seebeck.

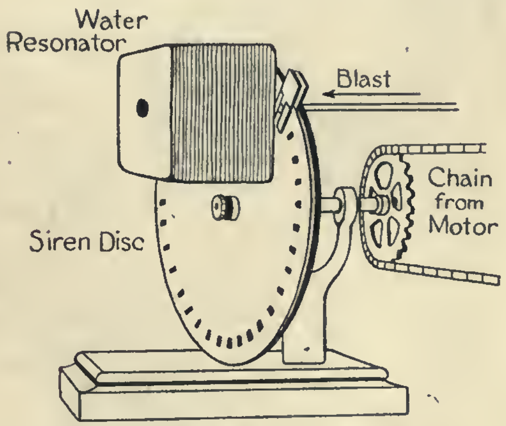

Fig. 7.—Puff siren with water resonator.

As a slit passes across the blast tube a jet of air issues for an instant. This is heard as a faint puff. As the disc is rotated more rapidly the puffs come oftener, until at one region a low tone appears. With still greater rapidity the pitch of the tone rises.

When a brass resonator is placed in front of the tube of the siren it sounds loudly when the frequency of the puffs is the same as that of the tone of the resonator, and also less loudly when it is in some other harmonic relation. For inharmonic relations the resonator is silent. Resonators with hard wells, therefore, cannot be used to produce sounds containing inharmonic components.

The soft-walled resonators of the mouth can be imitated by spreading pieces of meat over wire frames. As this has its inconveniences, a wire frame may be covered with a layer of absorbent cotton soaked in water. Such a resonator is shown in Fig. 7. The walls are quite inelastic. When such a water resonator is placed in front of the tube of the siren, it responds equally well to all tones of the siren, whether harmonic or inharmonic. Two or more resonators can be combined to meet the requirements for various vowels.

The theory of this vowel siren can be illustrated by the diagrams in Fig. 8. The puffs come as sharp blows almost instantaneous in character; they are indicated by the crosses. When such a blow strikes a resonator with soft walls, it arouses a vibration in the cavity that dies away very rapidly, as is indicated in the first line of the figure. The vibration is entirely gone before the next puff hits it. The response of the resonator is quite independent of the frequency of the puff. When, however, a puff strikes a resonator with hard walls, it arouses a vibration that dies away

Fig. 8.—Vibrations in a resonator in response to puffs. The puffs are indicated by the crosses. The first line shows the response of a resonator with soft walls. In the second line the puffs hit a resonator with hard walls in such a way as to maintain strong vibrations. In the third line the puffs hit the same resonator in a way to produce little or no effect.

very slowly. When the next puff comes, the result depends on its relation to the vibration still going on in the cavity. If the puff hits the resonator at a moment when its frequency would be a sub-multiple of the frequency of the resonator, then it will reinforce the vibration and make the resonator tone louder. This is illustrated in the second line of the figure. If, on the other hand, it hits the resonator at a moment one-half a period short of a harmonic relation, it will kill the vibration it finds. A very weak tone may be aroused by puffs with a frequency that is not a sub-multiple of the frequency of the resonator, but no strong response can be obtained outside the harmonic relation.

The siren with water resonators was constructed with the aid of the Hodgkins fund of the Smithsonian Institution of Washington. It produced most of the typical vowels with success. Under the Carnegie Institution the work was continued with an attempt to imitate more closely the conditions in the living body. Although the cheeks can be represented by water resonators, the roof of the tongue is somewhat more difficult; the roof of the mouth is quite an approach to a hard resonator. To imitate these conditions, a resonator was made of a skull supplied with cheeks and a tongue of gelatine. The tongue was removable, so that models of different forms could be inserted. The voice tone was obtained from a vox humana organ-pipe. The ultimate object was to find vowel resonators that would respond with specific vowels to any tone. These were then to be mounted on a reed organ as an extra register. All tones issuing from the organ could be made to pass through one of the vowel cavities, and the organ would thus sing the vowels. In most singing the consonants are a subordinate matter, and such an organ would aid the singing of a choir or a congregation. The beauty of such a vowel register in a large organ in a cathedral is quite beyond imagination. This investigation was also supported by the Hodgkins fund, but was discontinued on account of the work required for the study of speech curves.

The Structure of Vowels.

The study of speech curves and the making of vowel-producing instruments show that two groups of elements are to be found in a vowel.

The first is the voice tone. Three properties of this tone are to be considered. The pitch of the tone is given by the rapidity with which the laryngeal puffs are repeated. If V indicates the number of puffs per second, then $V=f(t)$ is the general expression of the fact that the pitch of the voice tone depends on the elapsed time. It might be supposed that, in singing a vowel on a given note, the pitch would remain constant. A study of a record by the tenor Caruso (not yet published) shows that he never keeps his voice on a constant pitch during a vowel, but makes continual small changes. A study of the vowel "oh" used as an interjection shows that the pitch of the voice tone changes to express the emotion and the meaning of the interjection according as it is spoken to express sadness, admiration, or doubt. In fact, it is quite possible to obtain an equation for V for each of the three cases. In ordinary speech the pitch of the voice tone changes from instant to instant. Every individual vowel has a melody of its own. This melody varies with the emotion, the meaning, and possibly other factors.

The intensity of the voice tone depends on the energy of the puffs from the larynx. If I indicates the puff energy, then $I=f(t)$ expresses the fact that the intensity varies from moment to moment. The speech curves show changes of intensity that express emotion and meaning. Even in song—as Caruso's curves show—the intensity is constantly varied in a way that makes his song a production of art, and not a mechanical performance.

The third factor of this group is the musical character of the voice tone. This depends on the *shape* of the puff from the larynx. The matter is of such importance that the following statement seems to be needed.

After a tuning-fork has been struck its vibrations slowly die away. Its curve is really not that of a simple sinusoid, but that of a frictional sinusoid

$$y=a.e^{-\epsilon\frac{2\pi}{T}t}, \quad \ldots \quad (1)$$

where y is the elongation at the moment t, a the amplitude or maximum elongation, T the period, e the basis of the natural system of logarithms, and ϵ the factor of friction or damping. The period T is affected by the factor of friction, but the amount is so small that it can be neglected here. The effect is to cause a decrease in the amplitude. When the value of ϵ is great, the curve is that of a sharp puff. When it is less, the puff is more gentle. If it were 0, the ordinary simple sinusoid would be obtained.

The puff from the larynx may be of a complicated form that should be represented by the sum of a series of frictional sinusoids. The complete equation would be

$$y=\Sigma a.e^{-\epsilon t}\sin\frac{2\pi}{T}t. \quad \ldots \quad (2)$$

This comprises the whole of the vibration of a single puff. It is a free, and not a forced, vibration. The musical or unmusical quality of the voice depends solely on the presence or absence of the various members of (2). The quality of the voice that distinguishes a Caruso from a costermonger lies exclusively in the laryngeal puff. This fact is of importance as contradicting the almost universally accepted theory of vocal training that is based on "tone-placing" by the supposed action of the vocal cavities as resonators to give the musical quality to the tone from the larynx.

The other group of elements comprises the tones aroused in the vocal cavities. A puff striking a cavity arouses one or more vibrations of the form of a frictional sinusoid as in (1). Each cavity will have its own factor of friction and its own period. As shown by the vowel siren, this response will be a free vibration independent of the voice tone and the periods that go to the vibration that makes up the puff. Every change in the sizes or openings of the cavities will alter the periods of these vibrations. The possible combinations for the cavities of the chest, pharynx, mouth, and nose provide for an almost endless variety of vowels.

The speech curves show quite unexpectedly that there is no such thing as a constant vowel. The vowel "o" in "so" changes its specific vowel character from beginning to end. The least change is found in German; more change appears in American. There is so much change in English that an American hears the vowel "o" as a sound starting like "oh" and ending like "oo." The statement that this English vowel is a diphthong composed of two vowels is incorrect. The vowel is a single sound that gradually changes greatly in character. There is no objection to calling it a diphthong provided it be recognised—as the speech curves show—that all diphthongs are really single vowels that change greatly in character. At the same time, it must be recognised that what is called a single vowel may change even more in character than a so-called diphthong; the change in a very short vowel, as in "but," is often surprising.

Just what constitutes the differences between the different vowels is a problem at present beyond the reach of science. The ear tells us that there are many sounds which we group together under the type "ah"; many others that would go to form the type "oo," etc. The speech curves show that the multiplicity of varieties under each type is almost beyond belief. In a general way we know that the impression from "ah" is that of a higher tone than from "oo," from "ee" higher than from "ah," and so on. All details of the tones in a single vowel are lacking. Every investigator has differed from every other one in regard to what tones constitute any particular vowel. As shown in this article, we can get so far as to say on what principles a vowel is built up. We can even get curves of the vowels of an accuracy that leaves nothing to be desired. We have not, however, any method of analysing these curves accurately into a series of frictional sinusoids with independent periods and factors of friction. We must probably wait for some mathematician to do for this problem what Fourier did for harmonic motion.

Toxic Root-interference in Plants.

THE earlier investigations of the late Mr. Spencer Pickering at the Woburn Experimental Fruit Farm on the action of grass on fruit trees, which were described in the third (1903) and thirteenth (1911) reports issued from that station, sufficed to show that, in spite of some variability in degree, there is a definite deleterious effect on the health and development of fruit trees caused by grass grown immediately around them. That this is a general result and not a matter of special soil or other local conditions at Woburn has been demonstrated by independent experiments conducted in this country at Long Ashton, Wisley, and other places. So marked is the crippling effect of the grass in some cases that death of the trees has resulted. On the other hand, the presence of numerous grass orchards in apparently healthy and vigorous condition in many parts of the country made the existence of any direct toxic action on the part of the grass, such as Mr. Pickering was led to postulate, appear doubtful. It was evident that the action, if any, must be relatively complex, and the later work at Woburn now shows that this is so. In the seventeenth (1920) annual report from that centre new evidence is recorded which indicates not only direct toxicity of grass on fruit trees, but also a similar effect for any one plant on another when the two are grown in close association.

It is therein claimed that the action of grass is shown to be due to toxic substances derived from the grass, and is not the indirect result of any adverse effect on soil conditions as regards aeration, available moisture, or plant food. In a series of experiments in which apple trees were grown in pots and the grass in shallow, perforated trays resting on the soil of the pots, the injurious effect was secured, notwithstanding that the grass roots, by being confined to the soil in the tray, could neither impoverish the soil in the pot below, nor deprive it of oxygen or water. A similar result was obtained when the grass was grown in sand, instead of soil, in the perforated trays. The presence of grass roots in the soil in which the tree was growing was thus immaterial for the manifestation of the dwarfing effect, and it follows that nothing which might be abstracted from the soil by them could be held accountable for the results. The converse view that grass added to the soil something deleterious to the tree appears to offer the only explanation, the toxic material presumably being conveyed from the trays to the soil in the pots by means of the drainage water from the former. Direct evidence was secured on this point by utilising for watering the trees the leachings from the grass trays, the trays in this case not resting on the soil of the pots, but being placed elsewhere. The injurious effect on the tree was as marked as before. When, however, the leachings were allowed to stand for twenty-four hours exposed to the air before being used for watering the pots, the trees apparently were unaffected.

It was considered by Mr. Pickering that these experiments prove that the leachings contain an oxidisable substance derived from the roots of the grass which in its unoxidised form is detrimental to the growth of the trees, but after oxidation is no longer of a toxic character. The suggestion that it is nothing more than carbon dioxide given off by the grass roots was, according to him, disproved by the results of a series of experiments in which the plants were grown in pots as above, "with or without a surface crop in the trays, watering them in one case with ordinary water, in another case with a saturated solution of carbon dioxide, and in a third case with clear lime water, which, since lime absorbs carbon dioxide, would presumably have the reverse effect of the carbon dioxide water." They were of a purely negative character, and in no way indicated that the toxic action of the surface crop was modified by the differential treatment. Also bearing on this point are observations, direct and indirect, in several of the numerous series of experiments made which tend to show that the toxin after "oxidation" actually serves as a nutrient to plants exposed to its action. As to the nature of this substance and the manner in which it is communicated by the roots to the soil, no positive views are put forward, but Mr. Pickering held that there was no reason to assume that it is excreted by the roots, and he was inclined to attribute its origin to the débris which roots furnish to the medium in which they grow.

The later phases of Mr. Pickering's investigations were mainly directed towards proving that the grass injury to fruit trees is only a particular case of the action of one growing crop on another. By means of experiments on lines similar to those already reviewed, he showed for a wide variety of plants a corresponding toxic effect, and, moreover, demonstrated that the action is reciprocal. It is not confined to plants of a different kind; it is at least equally marked when the associated plants are similar. Further, it follows that the individual plant tends to restrict its own growth through the toxin which it produces so long as that remains "unoxidised" in the immediate range of the root system.

A new light is thus thrown on the question of soil drainage, it being evident that soil conditions facilitating rapid removal of the toxin or its oxidation must tend to promote healthier growth, provided that food supplies do not escape. Differences in efficiency of drainage may accordingly be held to account for the divergences of grass effect on trees which have been recorded in various localities.

With every plant exerting a direct toxic effect on all others within its range, the phenomena of root-interference do not merely represent the outcome of competition for food supplies. Mr. Pickering gave particular attention to the aspect of the case where similar plants are grown massed together, and his observations are interesting not only in themselves, but also because of considerations raised by them of economic significance as applied to agricultural and horticultural crops. He found that where the mass of soil available is below a certain limit, the total amount of plant growth produced is independent of the number of plants present. This holds whether the individual plants are grown with their roots in separate compartments of the soil-containing receptacle, so that root-interference is eliminated, or in a similar-sized vessel without divisions which permits unrestricted root-interference; but it applies only to cases where the plants are of the same age. When some are younger than others, the latter grow more vigorously at the expense of the former in the undivided containers, but the total combined growth falls considerably short of the amount which the mass of soil is capable of producing with plants of equal age. The latter point is, however, reached when plants of unequal age are grown in the divided vessels with no root-interference. In such cases the toxic action of the older plant on the younger was thus definitely illustrated where root-interference was possible and the available growth standard was not nearly reached, indicating that the plants were prevented from utilising all the nutrient present.

The question of range of root-interference has become latterly of considerably increased importance in fruit culture. The present high cost of labour has driven fruit-growers to consider how to reduce the expenses of cultivation of their orchards and plantations. In some cases this has been attempted by grassing them down, but the trees generally suffer so severely that this method can be practised successfully only where local conditions minimise grass influence. Cover cropping, followed by the ploughing in of the cover crop to serve as green manure, is also receiving attention, particularly on account of the increasing difficulty of obtaining adequate supplies of farmyard and stable manure. Where the trees are grown on strong and relatively deep-rooting types of root-stocks, such as the stronger free stocks for apples, the toxic effect of the cover crop or grass may be relatively negligible, provided that the soil is deep and well-drained. With superficial rooting types of root-stock, such as the Paradise or dwarfing stocks for apples, however, the toxic influence of the surface crop will certainly be more strongly marked, and may be sufficiently pronounced to render grassing or cover cropping other than for periods of short duration not only dangerous in many cases, but entirely impracticable in some. The use of the latter forms of root-stock is accordingly open to objection on this score, and, in so far as the grower may be debarred from these alternatives in the treatment of his plantations, and confined to clean cultivation, the modern English policy of advocacy of dwarfing stocks may perhaps prove to be misguided.

The recent announcement of the closing down of the Woburn Experimental Fruit Farm, followed so closely by that of the regretted death of its distinguished director, marks the end of the most important systematic attempt to grapple with the problems of fruit culture since the days of Thomas Andrew Knight. Hotly disputed as some of the conclusions reached there have been, the general value of its contributions to pomological science stands, nevertheless, beyond question. Although further development of the subject in this country must now be left to other stations, the influence of Woburn will persist, and future investigators will find their work materially simplified not only by the constructive results achieved there, but also by the illustrations afforded of the pitfalls to which field experiments in pomology are liable.

B. T. P. B.

Obituary.

Sir William Peterson, K.C.M.G.

NOT only his own university, but also the university world at large, has suffered a great loss by the regretted death, on January 4, of Sir William Peterson at the comparatively early age of sixty-four. Among university presidents Peterson's range of college experience and activities was exceptional and probably unrivalled. A Scottish education at the High School and University of Edinburgh was followed by a course at the University of Göttingen, from which he went with high classical distinction to Oxford as a scholar of Corpus. After Oxford an assistant mastership at Harrow introduced him to the life of an English public school, and as assistant professor of classics at Edinburgh he strengthened his association with that ancient university. From that post he was selected at an unusually early age for the principalship of the newly established University College of Dundee, over the growth of which he watched for thirteen years. Its affiliation with St. Andrews gave him intimate acquaintance with that ancient institution.

When, therefore, Peterson went to McGill in 1895 to enter upon the main work of his life, he carried with him the classical and literary spirit of the old Scottish and English universities, the critical training of Germany, and experience in directing university work on modern lines at an industrial centre. It was an excellent preparation for one who had to build at Montreal on the foundations so nobly laid by the distinguished Canadian man of science, Sir William Dawson. He had to deal with the practical needs of a young country busy in developing great natural resources, and at the same time to uphold the best intellectual traditions of the motherland. Both aims were kept steadily in view during his twenty-five years as principal of McGill.

Peterson had the good fortune to secure the support of men whose ample means were reinforced by high ideals of civic duty. Sir William Macdonald had already begun his generous benefactions to the university in aid of applied science. To the Schools of Engineering and Physics and of Chemistry and Mining, and for the foundation and endowment of the Macdonald College of Agriculture, Household Science, and Teaching, he gave during his life or by his will more than 12,000,000 dollars. The School of Medicine had already gained a well-earned fame, but large contributions from Lord Strathcona helped to confirm its place in the front rank of medical institutions. The same benefactor supplied the money for building and endowing the Royal Victoria College for Women, and, in conjunction with Sir W. Macdonald, that for the Conservatorium of Music, both in close alliance with McGill.

In giving direction to these and other streams of munificence, Peterson found a large and congenial field for his marked organising ability. His knowledge of English and Scottish universities and the close connection he maintained with them gave him a great advantage in filling the numerous posts created by the new foundations.

A striking proof of the growth of McGill under Peterson's rule, of the large lines on which he planned, and of the insatiable demands of a great and growing modern university is furnished by the fact that his successor in office, Sir Arthur Currie, found it necessary to appeal for a further sum of 5,000,000 dollars to carry on the work. That the graduates of the university and the citizens of Montreal responded by subscribing more than 6,000,000 dollars indicates the confidence felt in McGill as Peterson left it.

Peterson's selection as one of the trustees of the Carnegie Foundation for the Advancement of University Teaching—of which he was for some time chairman—opened up for him a new field of experience, since it gave him an intimate acquaintance with the leading university presidents of the United States, and made him familiar with all aspects of American university life. It emphasised the unique position he held among heads of universities.

The strain put upon Peterson by the war broke him down. An ardent believer in the British Empire, he spared no personal effort in speech and writing to maintain Canada's interest and full share in the struggle for its safety. What he accomplished in his own institution to this end is best shown by the terms in which the Carnegie Foundation made it a grant of a million dollars "in recognition of the noble and devoted service and sacrifice of McGill towards Canada's part in the Great War." It was while speaking in support of an appeal for the sick and wounded that the collapse occurred which closed his academic career.

G. R. P.

Alexander Muirhead, F.R.S.

ALEXANDER MUIRHEAD, F.R.S., who died at Shortlands, Kent, on December 13, 1920, was born in East Lothian in 1848. His father, John Muirhead, abandoned farming and was attracted to London in the early days of cable telegraphy, starting a business in Regency Street, Westminster, in partnership with Mr. Latimer Clark. Young Alexander, who was afflicted with partial deafness all his life, the result of a childish accident, went to University College School, Gower Street, and then to the college, where he made rapid progress in chemistry and mathematics, and became a devoted pupil of De Morgan. He afterwards worked at St. Bartholomew's Hospital under Mathiessen, in whose laboratory, amongst other things, he worked out the problem of the Latimer Clark standard cell, and laid the foundation of life-long accurate work in connection with electrical standards. He took the D.Sc. in 1872, in electricity, and became scientific adviser to his father's firm, where John Perry and many another later distinguished man took advantage of the opportunities, then novel, for accurate and absolute electrical measurement.

Muirhead's great achievement was the invention of the artificial line with distributed capacity, and the consequent duplexing of submarine cables. This he accomplished, in the first instance at Aden, with great and permanent success.

After carrying on research work in his own private laboratory, and perfecting the electrical standards of capacity, which he practically established and afterwards handed over to the National Physical Laboratory, Muirhead began instrument-making at Elmers End, constructing especially those beautifully designed instruments employed in cable telegraphy.

In 1894 Muirhead's attention was directed to the possibility of practical telegraphy by means of Hertzian waves, and he afterwards devoted his attention to getting them recorded by a syphon-recorder, with elimination of all disturbances, and with accurate tuning. He communicated a joint paper to the Royal Society on this subject (see Proc. Roy. Soc., A, vol. lxxxii., 1909, pp. 240–256).

But in the early 'nineties a serious illness had made Muirhead permanently lame, and his bodily disabilities were such that only his pertinacious and enthusiastic spirit enabled him to continue in harness and to remain as mentally alert as ever. He gave sound and helpful advice in connection with the Pacific cable, and his judgment and experience and scientific caution, together with his profound devotion to accuracy, were universally respected.

Muirhead was elected a fellow of the Royal Society in 1904, but a few years later a slight paralytic stroke added to the already formidable incapacities which prevented him from taking his true place among British men of science. By the few who really knew him he was highly esteemed and much beloved. Oliver Lodge.

An excellent Colonial servant of the Empire has passed away in the person of William Harris, Government Botanist and Assistant Director of Public Gardens in Jamaica. Mr. Harris was born at Enniskillen on November 15, 1860, and after some years' experience in gardening was in 1879 taken on the staff at the Royal Botanic Gardens, Kew. Two years later he was appointed, on the Director's recommendation, to take charge of King's House Garden, Jamaica, Sir Daniel Morris then being Director of Public Gardens and Plantations. In due course Mr. Harris acted as superintendent in each of the five gardens in that island. On Mr. W. Fawcett's retirement in 1908, Mr. Harris became Superintendent of the Public Gardens in the Department of Agriculture; in 1917 he was appointed Government Botanist, and in 1920, a few months before his death, he was promoted to be Assistant Director. By his loss botanical exploration in Jamaica has suffered greatly. He was an indefatigable collector, and spent his holidays in the botanical exploration of every part of the island, roughing it in the bush, with the most meagre shelter for the night. Last year he suffered from his throat, and went to Kansas City, where his eldest son was living, to consult a specialist. The disease was found to be cancer, and he died in hospital on October 11, 1920. Mr. Harris had been a fellow of the Linnean Society since 1899. Botanically, he is commemorated by the genera Harrisia, Britton (Cactaceæ), and Harrisella, Fawc. and Rend. (Orchideæ), and many species have been named after him.

The death occurred on Friday, January 7, of Mr. S. A. Vasey, who for twenty-eight years directed the *Lancet* laboratory. Mr. Vasey was born on March 9, 1866, and received his medical education at Charing Cross Hospital Medical School, but he was early attracted to chemistry, and in 1883 became a fellow of the Chemical Society, and assistant to Prof. Heaton at the medical school. Prof. Heaton was at that time also supervising the *Lancet* laboratory, so Mr. Vasey joined him there as assistant, and on the death of the former in 1893 he took entire charge. His investigations covered an extraordinarily wide field; he undertook inquiries into the physics of gas lighting and cooking, the standardisation of disinfectants, the chemistry of natural waters, the food value of oysters and the risks involved in their breeding and supply, and many similar questions relating to public health. These topics will be sufficient to indicate the extent of the work he accomplished. Mr. Vasey was largely self-taught, and he was remarkable for the natural and easy way in which he applied the facts of science to the most commonplace occurrences of life. By his untimely death both the public health service and our contemporary have lost an old and trusted servant.

The death has occurred of the veteran microscopist, Mr. Thomas Maltwood, in his ninety-fourth year. Mr. Maltwood was a fellow of the Royal Microscopical Society, and took an active part in the proceedings of that society in the middle of last century. He is best known as the inventor in 1858 of the Maltwood finder, which consists of a scale of vertical and horizontal lines reproduced photographically upon a glass plate, by reference to which the location of a particular object or structure in a microscopic specimen may be recorded.

The death of Mr. Walter Pitt is announced in *Engineering* for January 14. Mr. Pitt was one of the leading authorities on harbour construction plant, and was chairman of the firm of Messrs. Stothert and Pitt, Ltd., of Bath. He was born in 1853, and was a member of the Institutions of Civil Engineers and Mechanical Engineers; he served on the council of the latter body from 1907 to 1917, and was chairman of the institution's research committee on wire ropes.

Notes.

THE Royal Geographical Society and the Alpine Club for some time have been planning an expedition to scale Mount Everest. The political obstacle which stood in the way has now, fortunately, been removed by the permission granted by the Tibetan Government, on representation by the Government of India, for the expedition to pass through Tibet. Mount Everest, which lies on the borders of Tibet and Nepal, probably within the latter State, has an altitude of 29,142 ft. The surrounding mountainous country has never been explored, and, in consequence, much preliminary work is required before the actual ascent begins. In the *Geographical Journal* for January Brig.-Gen. the Hon. C. G. Bruce discusses the lines of approach and the probability of the feat being accomplished. The route proposed by Gen. Bruce is from Darjeeling through Sikkim to Kampa Dzong in Tibet, and then eastward for about 120 miles by the Taya Sampo Valley, through the Tingri Maidan, to the northern slopes of Mount Everest. This route he believes would enable a base to be established both as high as, and as near as possible to, Everest itself. It might be possible to arrange for supplies to be sent through Nepal up the Arun River or by other routes. This year an expedition is to make a preliminary reconnaissance of the ground, and in 1922 the actual attempt will follow. So far the highest altitude reached in mountain-climbing is 24,600 ft., attained by the Duke of the Abruzzi's party on Mount Godwin-Austen in 1909. Bad weather prevented a higher altitude being gained. Dr. Longstaff reached 24,000 ft. on Gurla Mandhata in 1905. In the ascent of Mount Everest an attempt will be made to push a camp to at least 25,000 ft., and, by use of ample porterage and the best of food, to have the climbing party in perfect fitness for the last effort.

AN article in the *Pioneer Mail* of November 19 last "from a correspondent in Mesopotamia" throws doubt on the general optimistic estimates of the results that may be achieved there by irrigation. The difference between the former widespread fertility of the country and its recent barrenness is usually attributed to political influences; but the author considers that it is due to changes in the soil and in climatic conditions, and not to deterioration of the population. He explains the recession of the sea for 100 miles from Ur of the Chaldees by an upheaval which has so lowered the gradient that the irrigation of that area must prove unusually difficult. There appears, however, to be no trustworthy evidence of essential climatic change, and the retreat of the sea is probably due to silting. The arguments based on possible changes in the soil appear more weighty; the author holds that the good soil is limited to narrow strips beside the rivers, and that most of the land "may easily prove to be irreclaimable," as "a gigantic subsoil sea charged with salts" has slowly collected under the plains. He considers this waterlogging incurable by simple drainage as in India, owing to the lack of adequate slope. The conditions described in the article indicate that irrigation in Mesopotamia is a far more difficult undertaking than in India.

SIR OLIVER LODGE'S suggestions for the designation of the unit of positive electricity (NATURE, December 9, p. 467), and Prof. Soddy's rejection of them, provide the theme for a humorous ode in *Punch* of January 12. The concluding lines are as follows:

"And then the bellicose and caustic SODDY,
Who treats Sir OLIVER as if he were Poor Pillycoddy,
Or any ordinary hoddy-doddy,
Winds up with a sardonic observation
Upon the modern 'hydrophobic school,
With its inveterate aversion to anything wet;'
Showing that by a curious transmigration
The hate which theologians as a rule
Monopolised may now be met
In the most learned and exalted set
Of those whose scientific zeal and piety
Form the chief glory of the Roy'l Society."

It is typical of our ever-welcome contemporary to take a broad survey of individual and national characteristics, and to present them with knowledge as well as wit. We admire one and enjoy the other, and are flattered that correspondence in our pages should have provoked such sprightly verse. We trust, however, that the transference of the *odium theologicum* to scientific controversy will remain a fancy, even though Mr. Punch may thereby lose opportunities for his inimitable banter.

A SOCIETY for scientific research into psychic phenomena has been formed in Glasgow, with Mr. A. J. Balfour as president. Other officers are as follows:—*Vice-Presidents:* Prof. W. Macneile Dixon, Sir George Beilby, Dr. A. K. Chalmers, the Duchess of Hamilton, Miss Janie Allan, Mr. J. Arthur Findlay, Mr. Peter Fyfe, Prof. R. Latta, the Rev. John Lamond, Dr. Neil Munro, Dr. L. R. Oswald, Lord Sands, Prof. W. B. Stevenson, and Dr. Henry J. Watt. *Chairman of Council:* Prof. W. Naeneile Dixon. *Vice-Chairman:* Mr. J. Arthur Findlay. *Hon. Librarian:* Dr. J. Knight. *Hon. Secretary:* Miss Margaret H. Irwin, 58 Renfield Street, Glasgow.

THE short general account of the annual meeting of the Headmasters' Association published in last week's issue of NATURE ascribed to Dr. Mary Bell the remark that "there is no sin in a child helping itself to the contents of the mother's purse in order to buy presents for a teacher." Dr. Bell writes to say that these words do not represent exactly what she said. The meaning she intended to convey was that "the impulse to gratify a self-regarding instinct by gaining recognition by giving flowers to a teacher might be so powerful as to outweigh any idea of stealing on the part of the child. The stealing is wrong, but the thing to tackle is the desire to gain recognition, or whatever it was that led to the giving of the flowers, without the wherewithal to do so."

A GENERAL meeting of the Association of Economic Biologists will be held at 2.30 p.m. on Friday, January 28, in the botanical lecture theatre of the

Imperial College of Science, South Kensington, S.W.1. Mr. Llewellyn Lloyd will describe greenhouse white-fly and its control, and Mr. W. B. Brierley will give his personal impressions of some American biologists and their problems. Mr. Brierley was one of three foreign representatives invited to attend the American Phytopathological Conference held last year, and afterwards visited the chief educational and research institutions in Canada and the United States and many geographical areas of botanical and agricultural interest.

THE Air Ministry has issued a table showing the numbers of aircraft of all nationalities which departed for and arrived from the Continent and the total numbers of passengers who travelled on Continental air services during the quarter October-December, 1920. The totals of departures and arrivals of aircraft to and from the Continent since the opening of the first service on August 26, 1919, until the end of 1920 were: Departures, 2131; arrivals, 2022; grand total, 4153. British machines contributed 3321 to the latter figure, French 721, Belgian 104, and other nationalities 7.

THE PRINCE OF WALES has expressed his intention of being present at the Hunterian festival dinner of the Royal College of Surgeons on February 14 to receive the diploma of honorary fellowship to which his Royal Highness was elected on July 24, 1919.

DR. ROBERT S. WOODWARD retired from the presidency of the Carnegie Institution of Washington at the end of last year, and the duties of that office have been assumed by Dr. John C. Merriam.

IN the December issue of *Man* Mr. J. J. S. Whitaker gives an account of recent archæological research at Motya which has been going on since 1906, and of which no information, except a few letters in English newspapers, has hitherto been procurable. Motya differs from its sister-cities in Sicily which have passed from one control to another and in course of time have undergone total transformation. Motya, once destroyed, ceased to exist as a town, and its site remained desolate. One remarkable discovery is that of a cemetery in which the burials are formed by single urns, the contents of which, so far as it has been possible to determine them, consist almost completely of the cremated remains, not of human beings, but of domestic and other animals. If this conclusion is verified it will raise a very interesting problem for the archæologist and anthropologist.

A COMMITTEE has been appointed to organise a presentation to Prof. Percy F. Kendall upon the occasion of his retirement from the chair of geology at the University of Leeds, which will take place under the age-limit in June next. As a teacher Prof. Kendall has been stimulating and successful; as a scientific worker he has shown himself possessed of a brilliantly original mind, and he has achieved especially notable work in glacial geology and in studies of coal and the coalfield. Some recognition of this work is richly earned. Sir William Garforth is the chairman of the presentation committee, and the treasurer is Mr. J. E. Bedford, of Arncliffe, Headingley, Leeds.

ENCEPHALITIS lethargica, a disease characterised by stupor and paralysis, which came prominently into notice in 1918, is stated to have made its appearance again in France. A number of cases are reported from Marseilles, and at Douai an epidemic is said to be raging. It is suggested that the malady is periodic in appearance, like influenza, and it is of interest that epidemics of stupors are again and again recorded by the old medical writers. Cases apparently cured seem to be subject to fresh attacks, and there is some evidence that the cured cases may be "carriers" of the virus and convey infection to others.

"ANILIN-VIOLET in Copying Pencils Acting as a Spreading Caustic" is the subject of a review in *Medical Science: Abstracts and Reviews* for December (vol iii., No. 3, p. 239). If the point of a violet copying pencil penetrates into and is broken off in the tissues the result is quite different from a similar accident occurring with an ordinary graphite lead pencil. If the removal of the violet point be delayed it slowly dissolves, and the area of tissue around undergoes sub-acute inflammation with irritation of the nerve-twigs and pain at first, followed by anæsthesia owing to destruction of the nerves. The tissues undergo necrosis or death, and finally a sinus leading to the surface forms, through which the violet-coloured débris is discharged. There is an absence of suppuration, as the anilin-violet is an antiseptic.

DRS. CALMETTE AND GUÉRIN, of the Pasteur Institute, Paris, state that they have been able to protect animals against tuberculosis by means of a vaccine. Ten healthy heifers, six of which were vaccinated, were housed with five tuberculous cows for thirty-four months and then slaughtered. Of the four unvaccinated heifers three showed advanced tuberculosis. Of the six vaccinated heifers two which had been vaccinated only once showed a small amount of tuberculosis, while the four other animals which had been vaccinated three times showed no trace of the disease. It is now proposed to experiment with apes, and for this purpose an island has been acquired in French Guinea and liberal grants have been made by the Government for building and equipping laboratories and for their upkeep. The vaccine referred to is probably that described by Dr. Calmette (*Ann. de l'Inst. Pasteur*, vol. xxxiv., 1920, p. 554), which consists of tubercle bacilli that have been grown on a glycerin-bile medium for several generations.

IN the *Journal of Anatomy* for October (vol. lv., part i., p. 68) Mr. G. S. Sansom describes observations on the parthenogenetic segmentation of the ovum of the water-vole (*Microtus amphibius*) within the ovary. The process continues as far as the formation of two blastomeres and the division of these so as to give rise to the four-celled stage. Conditions of atresia of the follicles then become so acute that further development is impossible.

ACCORDING to the *Scottish Naturalist* (November-December), a walrus was seen off the Shetlands on many occasions from early in July until the middle of October. When first seen, about twenty-four miles north-west of Lerwick, the animal followed a fishing-boat for some distance. It is described by the lighthouse-keepers as bearing tusks about 15 in. long; it was almost black on the top of its head, but lighter about the rest of the head and back. This issue also contains an account of the breeding of the brambling in Perthshire, which makes the first authentic record of the breeding of this finch in the British Isles.

THE curious discovery of a diurnal variation in the size of human red-blood corpuscles is announced by Dr. Price Jones (*Journal of Pathology and Bacteriology*, vol. xxiii., p. 371). They are smallest on first waking in the morning, soon swell up when the subject becomes active, and reach a maximum about noon, which is maintained until bedtime. Short, violent exertion imposes a sudden rise on this daily curve, followed by a rapid return to normal; gentle exercise of longer duration has no special effect. Resting quietly in bed is evidently not the same as sleeping soundly, since it does not abolish the diurnal variation. Forced, violent breathing, whereby much carbon dioxide is washed out of the blood, causes a marked shrinkage, which disappears again in less than half an hour. The obvious inference that the size of the red cells varies inversely with the alkalinity of the blood is confirmed by experiments *in vitro*; but whether the phenomenon is due to the cells behaving like pieces of gelatin or to osmotic changes due to the exchange of salts between the plasma and cells is left undecided. It is possible that the increase of size in venous blood is of use in delaying the passage of the corpuscles along the pulmonary capillaries until the excess of CO_2 has been eliminated.

IN vol. v., part 8, of the Scientific Results of the Australasian Antarctic Expedition several kinds of insects from Macquarie Island are brought to light. Hitherto only a single species of springtail and two of shore-inhabiting flies were known from that desolate place. The present report, by Dr. R. J. Tillyard, is accompanied by appendices by Prof. C. T. Brues and Mr. A. M. Lea. Described therein are two new species of springtails, a new genus of wingless Diapriid Hymenoptera, and the larvæ and adults of a new Staphylinid beetle. It is noteworthy that the island contains no trees and the hillsides are clothed with dark green tussock grass, scattered among which are patches of the more brightly coloured Maori cabbage (*Stilbocarpa polaris*). Penguin "rookeries" are a striking feature of the island, and wherever they are present the vegetation is destroyed. The Collembola and the wingless Hymenopteron occurred under stones in these "rookeries," while among the great masses of kelp cast ashore during stormy weather various flies undergo their transformations. A Pyralid caterpillar and the larva and pupa of a Tipulid fly are also described in this report, without definite names being assigned to them. The occurrence of these few insects on this desolate island affords an interesting problem to students of geographical distribution.

A COMPLETE and up-to-date catalogue of all the species and subspecies of birds of the Nearctic and Neotropical regions from northern Greenland to Tierra del Fuego, including the West Indies, the isles of the Caribbean Sea, and those of the South Atlantic and Pacific Oceans the faunal relations of which are American, is attempted in the "Catalogue of Birds of the Americas," by Charles B. Cory (the Field Museum of Natural History, Chicago, Zoological Series, vol. xiii., 1918–19). The first instalments issued form vol. ii., those of vol. i. being held over in order that Mr. Cory may have the benefit of Prof. Ridgway's latest investigations on the aquatic and gallinaceous groups, which will appear in the concluding volumes of that author's great work on the birds of North and Middle America. The parts under notice deal with the forms comprised in the orders Strigiformes, Psittaciformes, Coraciformes, Trogones, Coccyges, Scansores, and Piciformes. The geographical distribution of each species and its racial forms, often numerous, is concisely given, also a short and judiciously selected series of synonyms—a very desirable adjunct in these days of never-ending changes in nomenclature, resulting in the disappearance of time-honoured names in favour of obscure dug-outs. Another important feature is the author's footnotes, devoted mainly to descriptions of the plumage of the many new species and still more numerous subspecies described since the publication of Prof. Ridgway's volumes, and of the American forms added to the great "Catalogue of the Birds of the World" published by the Trustees of the British Museum. Mr. Cory's work will be greatly appreciated by all who are engaged in the study of birds generally, and of their geographical distribution in particular.

THE inheritance of ten factors in the cow-pea (*Vigna sinensis*) has been studied by Dr. S. C. Harland (*Journal of Genetics*, vol. x., No. 3). The characters investigated included the presence of anthocyanin in stem and leaf-stalk, the colour of the seed-coat pattern, and pod and flower colour. The presence of anthocyanin is due to a dominant factor, while the seed-coat colours, which are black, brown, buff, maroon, red, and white, are believed to be due to various combinations of four factors. Several other relationships of factors are also made out. In another paper by the same author the results of breeding experiments with the castor-oil plant, *Ricinus communis*, are given. The presence of bloom on various parts of the plant is due to a single partly dominant factor, while the spininess of the capsule is also partially dominant to its absence. As regards stem colour, crosses between green and mahogany brown indicated the presence of two factors which show repulsion. Dr. Harland has also crossed certain varieties of the tropical hyacinth bean, *Dolichos lablab*. He finds the indeterminate habit of growth dominant to the determinate. Two white-flowered varieties gave a purple F_1, due to the presence of the factors C and R, the former producing a purplish seed-coat and stipular hairs, the latter, in the presence of C, converting white flower into purple, purplish seed-coat into black, and causing pigmentation at the nodes.

THE Oreodontidæ from Upper Eocene to Pliocene genera are reviewed by F. B. Loomis in a paper on *Ticholeptus* (*Merycochaerus*) *rusticus* (*Amer. Journ. Sci.*, vol. l., p. 281, 1920). The wealth and variety of material for the study of these artiodactyls, especially in Lower Miocene strata, and their peculiar limitation to American deposits render the diagram of their evolution useful to students of the mammalia.

BULLETIN 663 of the U.S. Geological Survey on "The Structural and Ornamental Stones of Minnesota," by Oliver Bowles, is effectively illustrated with coloured plates of polished specimens—a method of imparting information that in our islands has, we think, been left to private enterprise. A publication of this kind is obviously a distinct service to a community that also contributes liberally to research in the so-called "purer" branches of geology.

SOME broad features of Hawaiian petrology are dealt with by S. Powers in the *American Journal of Science* (vol. l., p. 256, 1920). The olivine nodules in the basalts are regarded as early products of differentiation brought up from lower levels, and the occasional trachytes that are described seem to be due to differentiation in local volcanoes after their connection with the main subterranean cauldron had been cut off. Useful maps are given of several of the islands.

ATTENTION may be directed to a very convenient glossary of the economic mineral productions of the United States published by the U.S. Geological Survey under the title of "Useful Minerals of the United States," Bulletin 624, a revision of Bulletin 585. This consists of two parts—the first a geographical index, in which the various States of the Union are given in alphabetical order, and under each the most important mineral productions of that State, also alphabetically arranged. The second part consists of a list of the names of some six hundred minerals in alphabetical sequence, in which the composition and general uses of each are given briefly, together with a list of the States in which it occurs in important quantities or in some noteworthy form. The work thus forms a very convenient index to the mineral production of the United States, and it would be a very great advantage if all important mining countries published lists on similar lines. The suggestion might with great advantage be followed by our Imperial Mineral Resources Bureau.

LIVERPOOL Observatory at Bidston, under the directorship of Mr. W. E. Plummer, has issued its report for the years 1917–19, which is published by the Mersey Docks and Harbour Board. It has not been found possible to issue annual reports as was the custom prior to the war. The signal-gun for time, which is for definite nautical purposes, was fired, without alteration for summer time, one hour after Greenwich mean noon. Seismological observations are regularly recorded, and in the tables published notes are made respecting the different phases. Temperature records in the reports are from thermometers mounted on the north side of the observatory; in former years, when observations were made from instruments mounted on the south side, the results gave too high a reading. There were 76 days in 1917 with no sunshine, 68 days in 1918, and 68 days in 1919. For wind velocity it is still assumed that the velocity of the wind is three times greater than that of the cups of the Robinson anemometer, although this factor is recognised as too large. The detailed daily meteorological observations are most complete, and a summary is given for the several months and for the year. The number of hours that the different winds blew during each day affords very useful information and is of great interest as associated with the varying character of the weather. There is much that can be followed with advantage at other subsidiary observatories.

VOL. XIV. of the Collected Researches of the National Physical Laboratory extends to more than 300 pages, and is devoted entirely to optics. Its characteristic feature is the aid it affords to the manufacturer of optical instruments, and of telescopes in particular. One of the fifteen papers reprinted is devoted to a description of the methods adopted at the Laboratory for the calculation of telescope objectives, and a second gives the corrections to the curvatures of the lenses of an objective when the glass of a new melt is not quite identical in refractive index with the glass previously used. Charts for assisting in the selection of suitable glasses for cemented doublets are given, and those cases in which the curvatures do not allow a doublet to be cemented are met by the substitution of a cemented triplet. In a paper devoted to refractometers of the critical-angle type, such as are used in commercial testing, it is pointed out how extensive the powers of these instruments are and how the actual instruments have in the past fallen short of the accuracy possible owing to mechanical defects. Modifications of the original Zeiss form of construction are suggested which, when the instrument is used with the proper precautions, should raise the accuracy considerably.

A MARKED degree of red sensitiveness in some "ordinary" gelatino-bromide plates was observed and recorded many years ago; it seems possible that the key to this unexpected result has been found by Mr. F. F. Renwick, who contributes a paper on "The Action of Soluble Iodides on Photographic Plates" to the January issue of the Journal of the Royal Photographic Society. Mr. Renwick finds that by treating a plate for a few seconds with a very dilute solution of potassium iodide there is really no fogging effect (as Dr. S. E. Sheppard stated about a year ago), but that the plate is rendered markedly orange and red sensitive. This he demonstrates by bathing an ordinary plate for from 15 to 60 seconds in a 1 in 20,000 potassium iodide solution, washing it with water and exposing it to a spectrum. This appears to be the first instance recorded of a colourless solution conferring colour sensitiveness. Mr. Renwick has tried a fair number of different salts, but so far has discovered only one other that acts similarly. Sodium or potassium cyanide in solution of a strength of one in from 2000 to 10,000 gives an exactly similar effect. The author leaves a theoretical discussion of these results to a future occasion.

THE investigation of soap solutions by Dr. McBain and his students at the University of Bristol has been continued by the demonstration that aqueous sodium oleate at temperatures between 0° C. and 25° C. can exist in any one of three forms: clear oily liquid sol, clear transparent elastic gel, or white opaque solid curd, all at one and the same concentration and temperature. Hitherto the last two types have not been differentiated; probably all previous communications dealt with soap curd, and some confusion has been introduced into the discussion of the nature of gels on this account. Soap sol and gel have been shown to be identical in all respects except elasticity and rigidity, which are characteristic of the gel form alone. A curd is a sol or gel from which nearly all the soap has been abstracted through the formation of white curd fibres of barely microscopic diameter. These researches, described in the December issue of the Journal of the Chemical Society, have important bearings on the theory of gels, and support the micellar view of Nägeli.

MESSRS. J. AND A. CHURCHILL announce for early publication a new edition—the eighth—of Lee's "Microtomist's Vade-Mecum." It has been prepared by Dr. J. B. Gatenby, who has had the collaboration of several other well-known biologists; thus Prof. Bayliss contributes a chapter on the theory of dyes and staining, Dr. Da Fano has recast the chapters on neurological methods, Dr. A. Drew has written a chapter on protozoological techniques, Dr. W. Cramer and the editor a section dealing with the fatty substances, the chapter on bone and teeth has been revised by Dr. J. T. Carter, and sections on mitochondria, Golgi apparatus, fat and yolk, chromatin, chromosomes and nucleoli, embryology, microchemical tests, colloid intra-vitam dyes, and tissue culture methods have been contributed by Dr. Gatenby.

WE have received a copy of the new edition of its catalogue of second-hand scientific instruments from the firm of Charles Baker, of 244 High Holborn, W.C.1. It is divided into twelve sections, each of which deals with a particular class of apparatus. Prominent sections are those devoted to microscopes, surveying instruments, physical apparatus of various types, and photographic material. That on microscopes contains some seventy items, ranging from single sliding-tube instruments to those carrying all the modern improvements. The firm has also a number of second-hand scientific books and periodicals for sale, including collections of various journals of microscopy and NATURE, vols. xxviii. to civ.

Our Astronomical Column.

APPROACHING RETURN OF PONS-WINNECKE'S COMET.—Among the periodical comets due to return this year that of Pons-Winnecke presents the most interesting possibilities. The comet will be near the earth at the time it arrives at perihelion at about the end of June or early in July next, and as its orbit lies very near that of the earth a meteoric shower seems highly probable.

The first abundant exhibition of meteors from this source appears to have taken place on June 28, 1916, when it was witnessed by Mr. W. F. Denning at Bristol, who pointed out in NATURE of July 27 of that year the significant resemblance of orbit between the meteors and Pons-Winnecke's comet.

The last return of the comet to perihelion occurred on September 1, 1915, and, the shower of meteors having been observed at Bristol ten months later, the stream must be fully 600,000,000 miles long. If the display should fail to be visible at the end of June next it should certainly return next year.

The radiant point is situated a few degrees north-east of the star Eta in Ursa Major, and the radiation appeared to be very diffused in June, 1916, so that it was difficult to ascertain the exact centre. In former years the comet of Pons-Winnecke was always sufficiently distant from the earth to escape contact of its materials with our atmosphere, but during the last half-century the planet Jupiter has materially disturbed its orbit, and brought that section near perihelion extremely close to the earth.

STELLAR PARALLAXES.—Yerkes Observatory Publications, vol. iv., part 3, contains parallaxes of fifty-two stars obtained photographically with the great Yerkes refractor by Mr. G. van Biesbroeck and Mr. H. S. Pettit. A yellow colour-filter was used, and the bright stars were cut down 6 mags. or thereabouts by a double rotating sector. The stars are partly fundamental ones, partly faint stars with large p.m. The following are some of the more interesting results:—Aldebaran 0·047″, Castor 0·059″, Procyon 0·307″, B.D. +67·552° 0·106″ (this is the first determination made for this star), Lal. 21185 0·382″, ζ Herculis 0·095″, Barnard's p.m. star 0·509″, and Vega 0·114″. The average probable error is 0·010″.

Two more Publications of the Allegheny Observatory (vol. v., Nos. 4 and 5) have been received, and contain parallaxes of eighty stars, many of them now determined for the first time. The average probable error is 0·008″. There are only two parallaxes exceeding 0·1″, viz. Pi II. 123 0·145″ and O.A.N. 21338 0·134″ (first determination). Other interesting stars are α Trianguli 0·045″, δ Cephei 0·006″, 54 Piscium 0·096″, β Andromedæ 0·033″, Furuhjelm's companion to Capella 0·071″ (this is easier to measure than Capella itself, and from the common p.m. the parallax must be appreciably the same), η Geminorum 0·016″, Lal. 33439 0·095″ (Adams and Joy found 0·087″ spectroscopically), and Pi XXIII. 218 0·092″.

CATALOGUE OF NOVÆ.—The Japanese *Astronomical Herald* for October, 1920, contains a very useful catalogue of novæ, giving their R.A. and decl. for 1900, the date of outburst, and other particulars. Tycho Brahe's star of 1572 is No. 1, and Mr. Denning's nova of last August No. 41. The average in the last thirty years has been just one per annum. The nova of 1885 in the Andromeda nebula and the other faint novæ recently detected in spiral nebulæ have not been included in the list. The galactic co-ordinates are given, and the distribution of novæ in the four quadrants is as follows:

Galactic Long.	No. of Novæ
0° to 90°	14
90° to 180°	8
180° to 270°	3
270° to 360°	16

The deficiency in the third quadrant does not seem to be explicable as a result of south declination, for there are practically as many stars south of the equator as north of it (twenty to twenty-one). There are fourteen stars south of decl. −20°, which is the full number to be expected in this zone, one-third of the whole sphere. Hence the unsymmetrical distribution gives some grounds for conjecturing that the galaxy may be nearer to us in the first and fourth quadrants.

Federal Science during the World-war: Geology in Austria-Hungary in 1914–19.

By Prof. Grenville A. J. Cole, F.R.S.

In Nature, vol. xciv., p. 94, on the last day of the eventful year 1914, a sketch was given of the publications of the Geologische Reichsanstalt of Vienna from 1911 to 1913. The reduction in the scope of the institute, necessitated by political rearrangements, was recently referred to with some regret, and, now that international communications are restored, we are enabled to welcome the volumes issued during the years of war. The maintenance of the *Jahrbuch* in its well-known handsome form is a remarkable testimony to the energy of Dr. Tietze and his staff. While machine-guns rattled above the glaciers of the Ortler and slaughter surged from Caporetto to the sea, the Reichsanstalt not only discussed questions of philosophic interest, but even printed the results in anticipation of the return of happier times. Colour-printed maps and sections and photogravures of fossils accompany these volumes, which from January, 1914, to December, 1918, occupy a width of 15 cm. on our shelves. The *Verhandlungen* give us an extra thickness of 7 cm. This method of statement may appear crude in a matter of scientific output; but could we have claimed as much from H.M. Stationery Office in London if a lithe and indefatigable enemy had been battering our defences no farther away than the line Middlesbrough—Baugh Fell—Morecambe Bay?

Many of the recent papers in the *Jahrbuch* naturally treat of local details, and describe observations made during long mapping in the field; but few of them are devoid of wider applications. The fascinating mass of the Wetterstein on the northern wall of Tirol occupied O. Ampferer and O. Schlagintweit in the *Verhandlungen* in 1912. K. C. von Loesch (*Jahrb.*, 1914, p. 1) has now made a close study of its "Schollenbau" and that of the parallel Mieminger range immediately to the south, which is well known to travellers down the Inntal between Imst and Innsbruck. Von Loesch is particularly concerned with the lateral movements that followed, after an interval of repose, the main overfolding from the south. His summing up fails to give a comprehensive view of the westerly movements of the isolated blocks—a feature first indicated by Ampferer. One would like to know whether these may be fairly compared with the settling down and spreading of the front of a wave that has subsided on a shore. The question of how far the tension evidenced by "explosive" outbreaks of rocks in Alpine mines and tunnels is a heritage from the Miocene movements is considered a few pages later by K. A. Weithofer, of Munich ("Ueber Gebirgsspannungen und Gebirgsschläge," *Jahrb.*, 1914, p. 99). His paper discusses such occurrences in general, and concludes that no single explanation applies equally to all.

E. Fugger (1914, p. 369) describes the delightful country of the Tennengebirge south of Salzburg, where the Triassic rocks of the Eastern Alps first reveal their beauty and fascination to the traveller on the road to Radstadt. He quotes from F. Wähner an explanation of the double gorge of the Salzach above Golling, where a climb is made to the Lueg Pass along a dry ravine partly choked with glacial detritus. After the Ice age the river failed to return to its old groove, from which it was banked out by débris, and it carved the deep and impassable gorge of the Oefen close alongside. A rock-ridge only 200 m. wide separates the two ravines.

As an example of research into the stratigraphical problems of the Eastern Alps we may cite W. Hammer's far-seeing paper on the Bündnerschiefer of the Upper Inntal, with its numerous sections, and two coloured maps on the large scale of 1 : 25,000 (1914, pp. 441–566). The Bündnerschiefer, corresponding with the *schistes lustrés* of the Western Alps, occupy small areas south of Landeck on the margin of the gneiss, and present the usual difficulties of correlation. Hammer records interesting breccias with limestone fragments containing radiolaria; but fossil evidence is practically wanting. He inclines to the view that the beds are metamorphosed elements of Upper Cretaceous rather than older Mesozoic strata. Exotic Triassic masses appear among them in a disconcerting way (section on p. 453, etc.), and pebbles of Triassic rocks occur in conglomerates of the Bündner series.

Hammer continues (1918, p. 205) his studies in the Landeck district by a description of the zone of phyllites, associated with mica-schists, that runs along the north side of the Silvretta and Oetztal gneiss from St. Anton on the Arlberg to the village of Roppen in the Inntal. The series dips towards and under the gneiss, just as the Bündnerschiefer do from an opposite direction. The phyllites are overlain unconformably by the Verrucano, which was formed between the Armorican movements and the Triassic period. Their relations with the gneisses seem due to the early earth-movements, but here and there intrusive gneisses have invaded them. An interesting type (p. 216), the "Feldspathknotengneis," occurs in the phyllite series, and is marked by the development of albite in an originally sedimentary rock. The growth of the felspar has no connection with contact-action.

F. Angel and F. Heritsch, both of Graz, found an almost ideal working-ground on the Stubalp, part of the noble wall of crystalline rocks that hems in the basin of Graz on the west. The position of Austria in the world-war was so enforced and so anomalous that we may sympathise with these geological enthusiasts when they write of their mountain fastness: "Die Liebe zur Heimat, die Freude an den Bergen hat uns immer wieder dorthin geführt, wo wir den Jammer des Krieges vergessen konnten. Die Forscherlust war die Begleiterin unserer Wanderungen." F. Angel contributes detailed petrographic studies of the rocks encountered, which include both a sedimentary and a gneissic series; but the chief point of general interest lies in Heritsch's conclusion (p. 203) that the whole mass and its present structure are of pre-Cambrian age. The Stubalp thus seems to be an antique block worked up, perhaps, but by no means obliterated in the later tectonics of the Alps.

The attention given in these recent volumes to Bohemia, mainly through the work of Czech geologists, leaves a serious heritage to the revived States that look to Prague as their intellectual centre. The old question of the Silurian "colonies," and the work of J. E. Marr in giving them a tectonic significance, come up again in E. Nowak's researches on the southern edge of the basin (1914, p. 215) and in F. Wähner's paper (1916, p. 50) on the structure of central Bohemia, which recognises in the basin the remains of a formerly extensive and crumpled mountain range. This seems to have existed in Upper Devonian times, and one is tempted to ask if, with the north-east strike impressed upon its constituents, it cannot be regarded as part of the Caledonian continent so well revealed in north-western Europe. The main folding, however, in Bohemia and Moravia, accompanied by great intrusions of granite and the formation of large areas of gneiss, occurred in connection with the "Variscan" movements—that is, in Upper Devonian and Lower Carboniferous times—thus heralding, and still at a long distance, the Armorican movements of the west. This fact is emphasised by Radim Kettner, writing from Příbram (1917, p. 251).

In the same year (p. 267) J. Woldřich examined the Cretaceous fauna of Neratovic, where concretions containing 50 per cent. of calcium phosphate interestingly occur. This discovery is compared with the presence of phosphatic nodules in the Cretaceous of France and England, and (p. 321) the fauna is described in relation to its western representatives. In the volume for 1915 (p. 1) C. Zahálka contributes a far-reaching memoir on the Cretaceous system in the Sudetic region and its equivalents in the western lands of Central Europe. This includes many pleasant references to the comradeship shown to the author by French geologists, and the name of Valmy, where the First Republic answered the proclamation of the coalised kings, appears here happily (p. 109) in connection with field-work on the zone of *Inoceramus labiatus*. There is much in this extensive paper to interest English geologists, who must, by the way, not overlook Richard J. Schubert's paper (1915, p. 277) on otoliths of Barton Cliff in Hampshire, collected by H. Elliot Watson and sent to the author by Col. C. D. Shepherd. Schubert's death at the head of his company in the heroic fight at Gorlice on the Russian front (obituary by O. Ampferer, 1915, p. 261), removed a very active and much-loved personality from the ranks of the Reichsanstalt.

British and Indian geologists may also note Rudolf Zuber's contributions to the geology of the Punjab (1914, p. 327), resulting from explorations organised by an English oil company in 1913. There are two highly suggestive diagrams showing the interlocking of different types of Eocene strata, including the salt-clay series, and their folding in the great Himalayan movements to form the present Salt Range.

Broad questions of petrography have not escaped the attention of the Reichsanstalt, such as Bruno Sander's "Beiträge aus den Zentralalpen zur Deutung der Gesteinsgefüge" (1914, p. 567), in which the stratified and folded structures in many crystalline rocks are recognised as of earlier date than the crystallisation of their present mineral constituents; or the extensive study of peridotites and their allies involved in F. Kretchmer's memoir on "Der metamorphe Dioritgabbrogang im Spieglitzer Gebirge" (1917, p. 1). Palæontology is represented by a number of short papers, including one by J. V. Želizko (1918, p. 113) on a small species of lion from the Pleistocene of Wolin, in southern Bohemia. One large folio memoir, on Oxynoticeras, by J. von Pia, was issued in 1914; it includes the usual considerations in regard to what constitutes a genus or a species, to which we are accustomed when ammonites are brought into the arena. In critical biography E. Tietze's "Einige Seiten über Eduard Suess" (1916, p. 333), a paper of more than 200 pages, is a very memorable review of the recent history of geology. Even the papers on economic subjects reflect the calm detachment of the institute, encouraged to carry on its work with a cosmopolitan outlook, during a catastrophe that has broken the bonds of man to man by more than inexorable death. Even F. von Kerner's study (1916, p. 145) of the water-supply in the Middle Dalmatian karst-region, with its valuable series of sections, will be to the advantage of the Slavonic peoples rather than to those who blasted their trenches on the Carso in the hope of retaining a sovereignty at Trieste. And so, indeed, it should be always. The Austro-Hungarian *Festland* has become broken into horsts and *Graben*; but will not time smooth the fault-scarps that now loom up as separating walls? The best guarantee of scientific co-operation is to be seen in the names of those who have, during years of bitterness and division, contributed in serene hopefulness to the sum of human knowledge.

Measurements of the Angular Diameters of Stars.

AFTER the successful measurement of Capella as a double star by Prof. A. Michelson's interferometer method applied to the 100-in. reflector at Mount Wilson, it was known that he intended to attempt the more difficult feat of measuring stellar diameters. The most hopeful stars to choose for the purpose are the giant red stars. Prof. Eddington made some estimates of their angular diameters in his inaugural address to Section A of the British Association last August (NATURE, September 2, 1920, p. 14). Taking the temperature and surface brightness derived from the distribution of energy in the spectrum, the angular diameter (which is independent of the assumed distance) is deducible from the apparent magnitude. The highest estimate for any star was that for Betelgeux, the value being 0·051″.

The daily Press of December 31 announced that Prof. Michelson read a paper before the American Physical Society in which he stated that he had determined that the diameter of Betelgeux was 260,000,000 miles, or three hundred times that of the sun. As the assumed distance of the star was given as 150 light-years, we may infer that the measured angular diameter was 0·061″—a close agreement with Prof. Eddington's estimate.[1] Once the angular diameter of a single Ma star is determined, those of all the stars of the same spectral type can be deduced from their apparent magnitudes. The huge bulk of Betelgeux is a striking illustration of Prof. H. N. Russell's theory of giant and dwarf stars. Its density is presumably very low, otherwise an improbably high value of the mass would result.

Some further details of the result obtained at Mount Wilson were communicated in a letter from Prof. G. E. Hale which was read at the meeting of the Royal Astronomical Society on January 14. The apparatus consists of two periscopes fixed to a frame at the object-end of the tube of the 100-in. Hooker reflector. The outer mirrors are some 20 ft. apart, but the distance is capable of being varied. The inner mirrors are about 4 ft. apart; this is merely a matter of convenience, the beams being brought down the tube on opposite sides of the Cassegrain mirror. An additional plane mirror is used for reflecting the light up the polar axis. The measurement of a star's diameter is effected by varying the distance between the outer mirrors and finding the points at which the interference fringes disappear. The actual observation is very tedious and difficult; it was stated that half an hour was required each time the mirror was moved before the visibility of the fringes could be tested. Moreover, in measuring a star disc, observations are

[1] A later communication gives 0·046″ as the measured diameter.

required in different azimuths to ascertain that we are dealing with a single circular disc, and not with two neighbouring discs, as in the case of Capella. The resulting angular diameter is 0·045"; Prof. Eddington had predicted 0·051" from the visual magnitude and assumed surface brightness, and Prof. Seeliger deduced 0·042" in a somewhat similar manner. The linear diameter found (about 300 times that of the sun) depends on the assumed parallax, which, unfortunately, is decidedly uncertain; further determinations seem urgently to be called for. Prof. Lindemann pointed out the extraordinarily low density that such a diameter implies if we assume that the mass is of the order of twenty-five times that of the sun.

Other stars for which a diameter determination is hopeful are Antares and Aldebaran, and possibly Arcturus. Sirius and Vega will doubtless be attempted, but with less prospect of success.

A. C. D. C.

Culture and Environment in the Cameroons.

FEW areas in the African continent present problems of greater interest to the anthropologist than the Cameroons. Although the Germans produced a considerable amount of literature relating to the area while it was under their rule, there is still a great deal of work to be done before the complex ethnology of the country is elucidated. Capt. L. W. G. Malcolm, who saw service in the Cameroons during the war, is preparing a monograph which will be one of the first-fruits of our occupation. At a recent meeting of the Royal Anthropological Institute he gave a preliminary account of certain questions connected with the distribution of types of culture and its relation with the geographical environment.

In the Cameroons there are three main racial stocks, namely, the Bantu-speaking tribes, the Sudanese, and the Pygmies. Subsidiary immigrant races occupy certain areas in the north-east. Between the Bantu-speaking tribes and the Sudanese there are a number of tribes, some of which do not speak Bantu languages, and there is a distinct boundary between the Bantu-speaking and Sudanese races which is determined solely by the geographical nature of the country.

The material culture of the grassland area reveals the fact that the problem is of a most complex character. When dealing with tribes of mixed affinities it is extremely difficult to determine the various strata. Not only is there a local mixing of the tribes, but there are also various elements which have been brought in by invading tribes. This is particularly the case in Bagam, where the tribe has been influenced particularly from Bamum, in the north-east, while from Babanki, in the north, various forms of iron weapons have been introduced. The Balis have introduced among the grassland tribes the sleeveless gowns worn by the men. After Hausa and Fulani elements and the influence of the forest-belt tribes have been eliminated, it would appear that the chief characteristics of the grassland culture are weapons of copper, iron, and brass; socketed spearheads; a simple bow made from raphia palm, with a flat bowstring; arrows with wooden points; shields, either plaited or reinforced with wood; wooden slit-gongs; drums with skin tympana and wooden tautening wedges; flanged iron bells; iron-working (smelting and smithing); brass castings (Bagam and Bamum); pottery (coiled in the north-east); jutan cloth and woven fibre; decorative art with triangles and zigzags; cicatrisation; filing or chipping of the incisors; smoking pipes of metal and clay; animal and ancestral cults; and the use of carved masks and images. One of the most obvious and striking peculiarities of the grassland culture, however, is the quadrangular hut, with pyramidal or conical roof, ranged in streets, which differs distinctively from the forest-belt hut standing in its own irregularly placed clearing.

Capt. Malcolm's careful analysis of the culture of one area only of the Cameroons, even in this preliminary form, was not merely an indication of the extremely interesting material which still awaits investigation; it was also a valuable object-lesson of the method of studying a backward population which should form the essential basis of our administration in this and similar areas.

The Science Masters' Association.

AT the invitation of the Board of the Faculty of Natural Science, the annual meeting of the Science Masters' Association was held in Oxford on January 4–7. About two hundred members attended, and by the kindness of the Master of Balliol and the President of Trinity they were housed in these two colleges.

The meeting began on the evening of January 4 with the address of the president (Mr. A. Vassall, of Harrow) on "Some Aspects of Science and Education." Mr. Vassall dealt with education in science from the preparatory school to the university, and showed the evils of teaching in the earlier stages as if all the boys were ultimately to become specialists. The teaching should be such as to give every boy an opportunity of realising the scope and aims of science. It should impart to every boy the understanding of scientific problems necessary for the equipment of a modern State, and not be merely a training for future work in science, which in many cases will never be taken up seriously.

A lecture on spectroscopy, given by Prof. T. R. Merton, was concerned largely with the part played by observation and technique; observation cannot be effective with faulty apparatus. In the spectroscopy of gases the influence of traces of impurities is very great, and many beautiful experiments were shown to illustrate the methods of dealing with them. The conditions under which nitrogen gives a band spectrum and a line spectrum were shown; a tube was exhausted and filled with helium sufficiently free to enable the conditions for obtaining either a band spectrum or a line spectrum to be demonstrated. Also, a striking experiment was shown by which the presence of neon in the atmosphere was made evident. The method of getting hydrogen into and out of tubes by means of a heated side-tube of palladium was illustrated, and the curious fluorescence of parts of the human body was shown by illuminating the audience by light of wave-length about 3660 A.U., obtained by using a quartz mercury vapour lamp and a screen of special glass devised by Prof. R. W. Wood.

There were demonstrations in the various University laboratories, illustrating much of the teaching work of the University and some of the current investigations. Demonstrations were also given of the use of the microscope for the study of crystallisation, by Mr. T. V. Barker, who had prepared a pamphlet outlining a course of study suitable for schools, and of glass-blowing by Mr. B. Lambert, who gave many valuable hints on dealing with operations which are constantly a source of difficulty in making apparatus. All these demonstrations were repeated next day, and the association is greatly indebted to the distinguished University teachers who expended so much time and care on them.

A lecture on the control of growth was given by Mr. J. S. Huxley. After explaining the characteristics of the life-cycle of all animals, the lecturer showed how the growing stage could be accelerated or retarded by external conditions in the case of some lower organisms, and illustrated cases where it can be reversed. Two opposing processes may be distinguished, and by stimulating one or the other the progress of the resultant change can be controlled. An interesting case was related of an Australian soldier whose mind, as the result of shell-shock, reverted to the infantile stage, but, happily, on his return to Australia it developed again to the normal condition. Mr. Huxley went on to describe experiments with mice, the average life of which had been extended about 20 per cent. beyond the normal duration, and the treatment of a rat which had its youth restored after reaching a state of marked senility. In conclusion, the opinion was expressed that in the course of time it would be possible to extend the duration of man's life very appreciably.

A lecture on indicators and the law of mass action was delivered by Brig.-Gen. Hartley. The lecturer pointed out and illustrated the confusion resulting from the idea of neutralisation, and showed that the way to obtain a clear insight was to regard the indicators as weak acids or bases (fortunately the tautomeric changes need not be considered here) and work quantitatively in terms of the hydrion concentration from the known dissociation constants. Brig.-Gen. Hartley illustrated this by making four sets of solutions in which the hydrion concentration varied by factors of 10 from 10^{-3} to 10^{-10} (made by adding to $N/10$ acetic acid the calculated amounts of a solution of sodium acetate, as by this method the accidental introduction of impurities does not seriously alter the hydrion concentration), and adding to all the members of each series methyl-orange, methyl-red, phenolphthalein, and litmus respectively. It was then evident between what limits of concentration the colour change occurs in each case. Graphs were made showing the resultant hydrion concentration when various amounts of a particular alkali were added to 25 c.c. of a given acid. From these graphs it was at once evident what would be a suitable indicator and how sharp the colour change would be. Some further graphs showed the immense difference that would result if the constant for water were to have a different value.

In a lecture on the Hedjaz Mr. D. G. Hogarth gave an account of the geographical conditions and a most interesting review of the political positions since 1914 and their bearing on the war in the East.

Throughout the meeting there was an exhibition of apparatus and books by manufacturers and publishers.

Research on the Pink Boll-worm.

THE pink boll-worm, the larval stage of the Tineinid moth, *Gelechia gossypiella*, Saunders, is responsible for considerable damage to cotton in most cotton-growing regions, and its importance in Egypt has led to an extensive study of its habits and of methods of control (H. A. Ballou, 1920, "The Pink Boll-worm," Report of Ministry of Agriculture, Egypt; L. H. Gough, 1919, "On the Effect Produced by the Attacks of the Pink Boll-worm on the Yield of Cotton-seed and Lint in Egypt," *Agricultural Journal of Egypt*, vol. ix.).

The pink boll-worm was first discovered in Egypt in 1910, probably having been introduced in cotton from India, and in 1912 it had attained a position of first importance as a pest of cotton in that country, and since that time it has been the principal pest of this crop.

In its adult state *Gelechia gossypiella* is a small moth with a wing-spread of between 15 and 19 mm. The general colour of fresh specimens is coppery-brown with blackish spots varying in size and intensity. The eggs are laid on the green parts of the cotton plant, and the larvæ make their way to a boll or bud, where they feed inside the developing seeds or upon the ovules. When fully grown, the larva measures 10 to 12 mm. in length, the pinkish colour occurring in broad transverse bars on a yellow ground, and may pupate in the boll or seed or enter the earth. The larval state lasts from ten to nineteen days, but late in the season the larva, instead of pupating when full grown, may enter a resting stage, in which it may remain for as long as thirty months. This is the most important stage in the life of the insect, and the principal effort at control is directed at the larvæ before and during this stage.

The pink boll-worm damages cotton-seed in the boll, and its attacks result in reduced and weakened lint and reduced seeds, which may be light in weight and of low germinating power.

Legislation has made it compulsory for all plants to be pulled, and the remaining bolls destroyed, by a certain date, which varies between December 15 and January 15 in different districts; it has enforced the provision of approved machines for treating all seed in the ginneries by heat or fumigation, and made it compulsory for all stores containing cotton-seed to be screened from May to August to prevent the escape of adults.

The first campaign on a large scale against the pink boll-worm was carried out in 1916, and aimed at the destruction of resting larvæ in the bolls left in the field after the crop had been gathered. The method which is recommended for the future is for the cotton sticks to be removed from the field before cleaning, taken to a central place, and there cleaned by drawing through a comb or rake, no sticks to be allowed into a village until all have been passed by an inspector as clean, and the unclean sticks destroyed.

The picking of the crop should be as early as possible, as the attack of the pink boll-worm is more severe late in the season, and also the later larvæ are more likely to pass into the resting stage by which the infestation of the following year is caused.

Treatment of cotton-seed by heat at a temperature of from 53° to 73° C. was found to be effective in destroying all resting-stage larvæ, while having little effect on the percentage of germination of the seed.

The Optical Glass Industry.

THE *Daily Telegraph* published in its issues of December 28 and 29 two articles on the optical glass industry in this country. In a leading article of January 6 it says that, as England gave her scientific experimenters no assistance, supremacy in this highly skilled industry passed over to Germany, the Government of which had had the insight and the foresight to gauge its actual and potential value. When war broke out in 1914 there was but one firm—Messrs. Chance Brothers and Co., Ltd.—manufacturing optical glass in the British Empire. The consequence was that during the first year of the war our armies and our fleets could not be equipped with the optical glass required. Thanks to the brilliant research work of Sir Herbert Jackson and his colleagues on the Glass Research Committee of the Institute of Chemistry; to the investigations and work of Messrs. Chance Brothers; and, later, to the work done by the Derby Crown Glass Co., Ltd., by the end of the war British optical glass was as good as German, and was being produced in quantities sufficient to meet every demand. Messrs. Chance Brothers were manufacturing in one year optical glass sufficient to meet three years of the whole world's peace demand before the war. The Derby Crown Glass Co., which, before it was requested to do so by the Optical Munitions Department of the Ministry of Munitions, had not made an ounce of optical glass, is now producing some seventy or more different types and varieties "of a quality," says Prof. Cheshire, "which challenges comparison with the best in the world." Nor is this all. The establishment of the British Scientific Instrument Research Association, of the Department of Technical Optics at the Imperial College of Science and Technology, and of the Department of Glass Technology at the University of Sheffield, and the work of the National Physical Laboratory are all designed to consolidate and extend the ground gained, so that our manufacturers may keep in the front rank and not again allow themselves to be outstripped. But, the *Daily Telegraph* points out, the industry is again exposed to the full blast of German competition, more formidable now than ever because of the state of the German exchange. The editorial article in our contemporary concludes by endorsing the demand of the industry that the Government shall implement the verbal assurances given during the war, and, by a system of importation only under licence for a period of, say, seven years, enable this industry—"of all others a key industry"—to be safely tided over this abnormal period.

Mineral Resources of the United States.

ATTENTION may be directed to Bulletin No. 666 of the United States Geological Survey, recently issued, entitled "Our Mineral Supplies," which gives a brief account of the mineral resources of the United States, compiled from the point of view of the importance of rendering the United States economically independent of the rest of the world so far as mineral output is concerned. Even before America took part in the war it was recognised that her stocks of imported minerals were likely to be exhausted, or at any rate seriously depleted, and that it was necessary to take measures to ascertain how far it was possible to replace these minerals from home resources. Certain minerals were imported from choice rather than from necessity, because they could be obtained of higher grade, or more conveniently, or more cheaply from abroad, and in these cases it was only necessary to stimulate the home production. In a few other cases the minerals were imported because they either did not occur at all or did not occur in workable quantities or under workable conditions within the United States. The list of such minerals is, however, surprisingly short. All minerals are here classified under three heads, namely: Class 1, domestic mineral supplies adequate to all probable peace and war needs of the United States; Class 2, domestic mineral supplies sufficient for a large part of the peace and war needs of the United States; and Class 3, domestic mineral supplies inadequate in quantity or quality, or both, for the peace and war needs of the United States. This last class includes only asbestos, chromite, graphite, manganese ore, monazite, nickel, nitrates, platinum, potash salts and tin, and in only three of these, namely, monazite, nitrates and potash, was there no production at all in 1913, and only in the case of nitrates was there no production in 1917. In many cases, even amongst those minerals that occur but sparingly, the production had increased immensely during those four years. Thus, for example, the production of chromite was 255 tons in 1913 and 43,725 tons in 1917. Although not written with that object, this bulletin gives a vivid impression of the wonderful natural resources of the United States.

University and Educational Intelligence.

BRISTOL.—Mr. W. A. Andrews has been appointed lecturer on applied chemistry at the Merchant Venturers' Technical College in succession to Capt. H. Stanley. Mr. Andrews is at present a member of the staff of the Cardiff Technical College.

CAMBRIDGE.—The alternative scheme drawn up by one-half of the Syndicate on the relation of women students to the University will be submitted to the Senate for approval on February 12. A grace is proposed expressing the approval of the Senate of the incorporation of Girton and Newnham Colleges into a University, which Cambridge University would assist and co-operate with in various ways. The women's colleges have given notice that they will not take any steps towards the formation of a separate University even if the report is approved, so that the question will not apparently be much affected whichever way the voting goes.

Prof. Burkitt has offered the University, on behalf of a number of people interested in Oriental archæology, a sum of 20*l*. annually to enable the University to become "a subscribing learned society" to the British School of Archæology in Jerusalem. This will give the University the power to nominate one student at the school.

WE have received a copy of the annual report and statement of accounts of Livingstone College, E.10, for the year 1919–20. For more than three years during the war the buildings were used as a hospital for wounded soldiers, but they have now reverted to their proper function of training missionaries in the elements of practical medicine and surgery. The usefulness of the college has been extended by the decision to admit women as students. It is also announced that a special residential vacation course will be held in July this year on the care of health in the tropics with practical clinical work. In spite of the strictest economy the debit balance increased by 360*l*. during the year, and the deficit now amounts to 931*l*. Donations towards the financial needs of the college are earnestly solicited.

FROM the *Pioneer Mail* for December 24 we learn that the Raja of Mahmudabad inaugurated the Muslim University of Aligarh on the morning of December 17. The proceedings began with a recitation from the Koran, after which the Raja Sahib, who is the first Vice-Chancellor of the new University, read his inaugural address. He gave some account of the history of various Islamic universities, and expressed the hope that the new institution would cause a revival of old Islamic arts and sciences as well as bring modern science within the reach of Muslim youths. The same evening, at the dinner given by the Vice-Chancellor, the latter suggested that the new University should endeavour to raise funds to render it independent of Government assistance; to start this fund he himself promised to give a lakh of rupees (6666*l.*).

THE *Daily Mail* is offering four scholarships, each of the total value of 250*l.*, for students who intend to study for the degree of Bachelor of Commerce at London University. Candidates must be British-born, and they must be engaged, or about to engage, in whole-time business employment. The qualifying examination will be the London Matriculation Examination of June, 1921, and candidates must enter for this in addition to applying for the scholarships. Application forms for candidates living within the 20-mile radius of London will be available at the Efficiency Exhibition, which will open at Olympia on February 10; those living outside this radius can obtain the forms after that date by applying for the catalogue of the exhibition, price 1*s.* 3*d.*, to "Efficiency Catalogue," *Daily Mail*, Carmelite House, London, E.C.4. Candidates must show that they are engaged, and intend to continue to be engaged, in whole-time employment in business and that they propose to pursue a regular course of study for the degree in commerce. The scholarships will be tenable for four years, and payments of the grant will be subject to the student's progress.

THE second Congress of Universities of the Empire will be held at Oxford on July 5–8 of this year. As at the first congress, which met in London in 1912, it is expected that there will be a large attendance of representatives of the universities of the United Kingdom and of the King's Dominions overseas. For a month all delegates from overseas will be the guests of the home universities; the latter will be visited in turn either before or after the full meeting of the congress. In August last letters were addressed to all the universities overseas, and in October a similar circular was sent to all the universities of the United Kingdom, asking for suggestions for the agenda for the coming congress. A sub-committee consisting of the officers of the Bureau and the Vice-Chancellors of Oxford and Cambridge sat to consider the answers received, and it was decided that the second congress should be devoted to considerations of the chief fields of university activity, particularly to those which are new and likely to be viewed from diverse points of view. The agenda therefore consists of subjects dealing with the position of the universities with regard to secondary, adult, technological, and commercial education; with university curricula, research, and finance; and with the problems of the interchange of teachers and students between different universities. Lord Curzon, Mr. A. J. Balfour, Lord Haldane, Lord Crewe, Lord Balfour of Burleigh, Lord Shaftesbury, Lord Robert Cecil, and Lord Kenyon will preside at successive meetings of the congress.

IN March of last year a Royal Commission was appointed to inquire into the financial resources and working of the University of Dublin and of Trinity College, Dublin, and to consider the application made by the University for State financial assistance. The report of the Commission, of which Sir Archibald Geikie was chairman, has been issued as a Parliamentary Paper (Cmd. 1078). The Commissioners estimate that the annual cost over and above the present expenditure of the college of carrying into effect various recommendations will be 49,000*l.*, and that a further sum of 113,000*l.* will be required to provide for new buildings and equipment, reconstruction, and necessary repairs. They are unanimously of opinion that the existing resources of the University of Dublin should be augmented from public funds by an immediate non-recurrent grant of 113,000*l.* and an annual subsidy of 49,000*l.* The following are some of the annual grants recommended:—Physics, 1350*l.*; Dunsink Observatory, 900*l.*; chemistry, 2228*l.*; botany, 2050*l.*; geology, 1400*l.*; zoology, 2150*l.*; medicine, 5692*l.*; engineering, 4270*l.*; agriculture, 2000*l.*; the library, 1588*l.*; research or travelling exhibitions, 2400*l.* Of the capital expenditure 31,500*l.* is recommended for new construction and renovation for the School of Chemistry; 2000*l.* for gardens for the School of Botany; 7000*l.* for a new building for the School of Zoology; 16,000*l.* for a new building for bacteriological research; 19,500*l.* for the Department of Physiology; 25,000*l.* for the extension of premises and equipment of the Department of Engineering; and 12,400*l.* for a new library building and equipment.

ENGINEERING education in the United States is carried on in two types of institution: universities and independent institutes (Higher Education Circular, No. 20, of the Bureau of Education, 1920). The American university differs in its organisation from the universities both of Latin America and of Europe. Typically, it contains a number of "schools" to which students are admitted direct from the secondary schools, and one or more divisions, such as medical and law schools, to which students are admitted only after they have completed two years' training in one of the schools mentioned above. Engineering is a school which offers professional training leading to engineering degrees to students straight from the secondary schools; generally, engineering schools are administered as separate units. The independent institutes are usually devoted solely to engineering, and, academically, the training they provide is of the same standard as that offered by the universities. Both provide a course lasting four years which leads to the degree of B.S. in some branch of engineering; it is at the same time, in spirit and in tendency, a professional course fitting young men for the immediate practice of their professions. In consequence, the curriculum is determined by the requirements of the profession, and, therefore, somewhat rigidly prescribed. Recently the tendency has been to lengthen the training, and several universities are now offering five- and six-year courses. The expenses of foreign students attending American institutions vary; tuition fees range from 150 to 300 dollars per annum in the privately endowed schools, and in State-supported institutions from 20 to 125 dollars a year. Living expenses are assessed at 500 to 700 dollars per annum, and further allowance must be made for travelling expenses when the institution is some distance from ports of entry. A list is given of 127 schools providing four-year courses in engineering which show an enrolment of 51,400 students; one school alone, the Massachusetts Institute of Technology, has accepted 2291 students, while fourteen others have each more than 1000 pupils.

Calendar of Scientific Pioneers.

January 20, 1907. Agnes Mary Clerke died.—Widely known for her astronomical writings, Miss Clerke, like Mary Somerville, Caroline Herschel, Ann Sheepshanks, and Lady Huggins, was an honorary member of the Royal Astronomical Society.

January 21, 1892. John Couch Adams died.—Few scientific achievements have aroused more interest or more controversy than the discovery of Neptune, and the careers of few astronomers have opened so brilliantly as that of Adams, who simultaneously with Leverrier worked out the calculations demonstrating the existence of this planet. After working at the problem for two years Adams in September, 1845, communicated his results to Challis, and in October to Airy. Leverrier's papers were published shortly afterwards, and Neptune was first seen by Galle at Berlin on September 23, 1846. Adams, who was born in Cornwall on June 5, 1819, became Lowndean professor in the University of Cambridge in 1858, and in 1861 succeeded Challis as director of Cambridge Observatory.

January 22, 1799. Horace Bénédict de Saussure died.—Saussure was the first great explorer of the Alps. A naturalist and a physicist, he has been called "the founder of experimental geology," and he is said to have been the first to place meteorology on a reasonable basis.

January 22, 1840. Johann Friedrich Blumenbach died.—For more than fifty years Blumenbach held the chair of anatomy at Göttingen, and wrote works on physiology, anatomy, embryology, and ethnology which became European text-books.

January 22, 1867. Sir William Snow Harris died.—A prominent worker in electricity, Harris by his new form of lightning conductor added greatly to the safety of ships at sea.

January 22, 1900. David Edward Hughes died.—Son of a bootmaker who emigrated to America, Hughes in 1855 patented his type-printing telegraph, and in 1857 came to England. In 1878 he patented his microphone. Recognised as one of the greatest scientific inventors of the age, he amassed a fortune of nearly half a million sterling, which was given mainly to London hospitals and scientific societies.

January 24, 1877. Johann Christian Poggendorf died.—Poggendorf was for fifty years editor of the *Annalen der Physik und Chemie.*

January 24, 1914. Sir David Gill died.—Astronomer-Royal at the Cape of Good Hope, Gill was one of the best known astronomers of his day. He is especially remembered for his great geodetical operations, his determination of the solar parallax, and his pioneering work in connection with the photographic survey of the heavens.

January 26, 1631. Henry Briggs died.—On the foundation of Gresham College, London, Briggs was appointed to the chair of geometry, the first of its kind in England. He was also the first to hold the Savilian chair of geometry at Oxford.

January 26, 1823. Edward Jenner died.—After twenty years' experimenting, Jenner on May 14, 1796, made his first vaccination. Three years later seventy London doctors declared their confidence in his discovery, which was soon promulgated throughout the world. Parliament acknowledged the country's indebtedness to him by voting him sums totalling 30,000*l*.

January 26, 1895. Arthur Cayley died.—Senior wrangler in 1842, Cayley for many years was a law conveyancer, but in 1863 became first Sadlerian professor of mathematics at Cambridge.

E. C. S.

Societies and Academies.

LONDON.

Aristotelian Society, January 3.—The Very Rev. Dean W. R. Inge, president, in the chair.—C. A. **Richardson**: The new materialism. The new materialism takes the form of a denial of anything corresponding to the idea of "mind" or "subject." Unlike the old doctrine, it does not affirm the reality of atoms; its ultimate stuff is sense-material. It reduces the subject of experience to a series of sense-data, and the sense-data are conceived as ontologically independent of the subject. Against this it was argued that the subject of experience is a real metaphysical existence. Experience consists in spiritual activity, and one type of this activity is sense-experience. The content, sense-data, is the particular form the activity assumes, and the form is determined by the interaction of individual subjects. The most pressing philosophical need of the day is to come to an agreement on this point. Until we are agreed as to whether there exists the subject or mind there must be disagreement on the fundamental matter of philosophy, namely, the entities in terms of which theories may be formulated. Without a common platform philosophy will be left behind, a curious relic, by the intuitive wisdom of the vast mass of humanity.

DUBLIN.

Royal Dublin Society, December 21.—Dr. F. E. Hackett in the chair.—J. J. **Dowling** and D. **Donnelly**: The measurement of very short intervals of time by the condenser-charging method. An investigation of the degree of accuracy obtainable in the measurement of short time intervals by a method in which the time interval is determined by observing the charge taken up by a condenser connected to a source of steady electromotive force through a known resistance during the interval in question. It was found possible to measure intervals of thirty millionths of a second with an accuracy of one millionth of a second.—J. J. **Dowling** and J. T. **Harris**: An apparatus is described whereby a spark-gap, included in the secondary circuit of a high-tension transformer, is rendered conducting during one-half of each cycle, thus permitting a current to flow in one direction only. The primary current energises an electromagnet which sets into vibration the diaphragm of a König manometric flame, situated in the spark-gap. A subsidiary winding allows the magnet to be polarised by a steady current so as to cut out each alternate flame oscillation. Various tests of the apparatus are described which indicate that very complete rectification is obtainable.—J. J. **Dowling**: A sensitive valve method for measuring capacities, with some important applications. A steady source of alternating e.m.f. is connected to a circuit consisting of a high resistance in series with a condenser. The drop of potential across the resistance is proportional to the capacity of the condenser. The filament and grid of a three-electrode valve respectively are connected to the ends of the resistance, and variations of the capacity of the condenser thus bring about corresponding variations in the plate current. The greater part of this is balanced by an opposed steady current derived from a battery connected through an adjustable resistance to the galvanometer terminals. Using a galvanometer of high sensitivity, very small variations can be detected. The application of this principle to the construction of an ultra-micrometer and of a micro-pressure gauge are described. Displacements of the order of 10^{-7} cm. are easily measurable. Further work is in progress.

PARIS.

Academy of Sciences, December 27.—M. Henri Deslandres in the chair.—H. **Douvillé**: The Eocene of Peru. From the examination of a number of fossils sent by Prof. Lisson (of Lima) it is concluded that the views of Grzybowski, published in 1899, must be modified. Only the upper portion of the Payta strata can still be attributed to the Pliocene; the remainder of the Tertiary Peruvian layers reproduces very closely the constitution of the Californian Eocene, and, like the latter, contains lignite and oil. —P. **Termier** and W. **Kilian**: The age of the glistening schists of the Western Alps. The age of these deposits has been much discussed with widely varying deductions. The authors, after a survey of the existing data, conclude that there is certainly Lias in these strata, and very probably some of the Upper Trias.—C. **Richet** and H. **Cardot**: The hereditary transmission of acquired characters in micro-organisms. A study of the influence of toxic substances (antiseptics) on the lactic bacillus, of the immunity acquired by successive generations, and of the transmission of this acquired immunity to antiseptics.—G. **Charpy** and J. **Durand**: The melting point of coal. It is well known that with certain coals a rise of temperature produces a softening, sometimes called the melting point. This agglomeration point is very important from the point of view of coke manufacture, but it would appear that no exact measurements of this temperature have been made. A description is given of the method devised to give definite readings, with results for eight coals. The "melting point" is characteristic for a given coal, and is independent of the amount of volatile matter present.—L. E. **Dickson**: Polynomials equivalent to determinants.—S. **Bays**: Cyclic systems of Steiner.—G. **Giraud**: Reply to a note by M. Fubini on automorph functions.—P. **Humbert**: Hypertoroidal functions and their connection with hyperspherical functions.—T. **Varapoulos**: The zeros of the integrals of a class of differential equations.—R. **Birkeland**: Resolution of the general algebraical equation by hypergeometrical functions of several variables.—B. **de Fontviolant**: Calculation of the strengths of circular bridges.—H. **Godard**: Observation of the Skjellerup comet made at the Bordeaux Observatory (38-cm. equatorial). Position given for December 17. The comet is a nebulosity of about 1′ diameter without visible nucleus: 11th magnitude.—M. **Michkovitch**: Observation of the Skjellerup comet made at the Marseilles Observatory (26-cm. Eichens equatorial). Position given for December 20.—A. **Hansson** and H. **Jelstrup**: Spectrum of Nova Aquilæ III. in July, 1920. The two photographs, one of two hours' and the other of one hour's exposure, showed a large number of bright lines on a background of continuous spectrum, and, consequently, the identification of the bright lines proved to be difficult. A table of the wave-lengths of the lines identified is given, and includes lines attributed to calcium, helium, iron, hydrogen, and to the element characteristic of nebulæ.—L. **Bloch**: Comparison of the theories of Lorentz and Mie.—P. **Vaillant**: The variations in the electrical conductivity of calcium sulphide with temperature. When a thin layer of calcium sulphide previously exposed to sunlight is heated its electrical conductivity rapidly increases, passes through a very marked maximum, and then decreases almost to zero. The phenomenon is closely connected with the state of phosphorescence.—G. **Contremoulins** and E. **Puthomme**: The determination of the time of exposure in radiography.—P. **Lebeau** and A. **Damiens**: The composition of some coke-oven gases. Analyses of four samples of coke-oven gas made by a method described in an earlier publication. Compared with coal-gas, the main differences are the lower percentage of hydrogen and the high proportion (20 per cent.) of nitrogen.—H. **Le Chatelier**: Remarks on the preceding paper.—M. **Godchot**: The catalytic addition of hydrogen to suberone. By the action of reduced nickel and hydrogen at 175° C. suberone is converted into suberol. Attempts to form a six-carbon ring from suberone by the action of active nickel at 240° C. were unsuccessful, differing in this respect from *cyclo*heptane.—P. H. **Fritel**: The presence of the genera Phragmites and Nephrodium in the Pleistocene clays of Benenitra (Madagascar).—A. **Nodon**: Solar action and the recent atmospheric disturbances.—P. **Mazé**: Researches on the assimilation of carbon dioxide by green plants. The fresh leaves were heated to 60° C. under reduced pressure and the distillate was received in an ice-cooled receiver. In no case could formaldehyde be detected, but nearly all plants gave ethyl alcohol, acetaldehyde, and nitrous acid. Beans and maize collected in fine weather gave acetylmethylcarbinol, elder leaves gave hydrocyanic acid and glycollic aldehyde, whilst lactaldehyde was obtained from poplar leaves.—A. **Desgrez** and H. **Bierry**: Nitrogen equilibrium and carbohydrates in the food ration. Below a certain limit no other food can replace carbohydrates.—A. **Mayer**, M. **Plantefol**, and F. **Vlès**: Poisoning by the nitrohalogen methanes. Chloropicrin has the most powerful toxic effect; bromopicrin and dichlorodinitromethane are from eight to ten times less active.—R. **Anthony**: Tubular pseudo-hermaphroditism in male Cetaceans.—A. **Dehorne**: The spermatogenesis of *Corethra plumicornis* and eupyrene chromosomes.—M. **Doyon**: Participation of the cellular nuclei in the phenomena of secretion. The anti-coagulating properties of the nucleinic acid of the intestine.—A. **Malaquin**: Sexual and asexual reproduction.—L. **Cavel**: The purification of sewage by the activated-sludge method.

SYDNEY.

Royal Society of New South Wales, December 1.—Mr. J. Nangle, president, in the chair.—Dr. J. A. **Pollock**: The stethoscope, with a reference to a function of the auricle. Various forms of stethoscope are considered; the acoustic determination of surface vibrations has a definite dynamical aspect when the disturbances are very small. Detection in all the instances described depends on the movements of the surface relative to a steady mass elastically connected with it. In detecting small movements with the old-fashioned stethoscope, or after the manner of the tracker, the mechanism is supplied by the head and ear, the auricle having the very definite function of acting as the elastic connection between the mass and the surface. In other cases where the air disturbances are led by tubes directly into the ear passages the mechanical action is recognisable as associated with the instruments.—A. R. **Penfold**: The essential oils of *Leptospermum odoratum* and *L. grandiflorum*. The principal constituents of the former are eudesmene and aromadendrene (sesquiterpenes), eudesmol (sesquiterpene alcohol), α- and β-pinene, with smaller amounts of a rose-odour alcohol, esters, and phenols. This is the first time that eudesmene has been found occurring in Nature. *Leptospermum grandiflorum* consists principally of the same two sesquiterpenes with an unidentified sesquiterpene alcohol.—M. B. **Welch**: Eucalyptus oil-glands. The oil was formerly considered to be present as a single globule contained in a small cavity, but it would now appear that it is rather in the form of an emulsion in cavities which usually approach the surface. Oil occurs also in the stems, buds, fruit, and, in rare species, in the barks. The glands are often more or less devoid of contents, and in the different species show decided variation in arrangement and number. Their origin is evidently due to the separation of certain cell-tissues and their later disintegration.—Dr. G. **Harker**: The temperature of the vapour arising from boiling saline solutions. It is shown that the temperature of the vapour can be obtained well over 100° C. by boiling the solution in a hypsometer, either by a Bunsen flame or by admission of steam from water boiled in a separate vessel. With a solution of calcium chloride boiling normally at 115° C. a temperature of 106° C. was obtained for the vapour at a point 10 in. above the boiling solution. It is claimed that under the conditions of the experiment superheating could not take place.—J. H. **Maiden**: Notes on two Acacias. (1) The first is a spreading shrub, which may, however, assume an erect habit and become 10 ft. high. Its affinities are shown in that it was formerly known as *Acacia doratoxylon* var. *angustifolia*. It differs from that species in its habit, in its smaller size, in the short sessile flower-spikes, which are axillary and not racemose, and in the hairy ovary. It is found chiefly in the New England granite country from Howell, near Tingha, as far north as Stanthorpe and the Toowoomba district in Queensland. (2) The second wattle is submitted as a form or race of *Acacia pycnantha*, Benth., or a new species. In its ordinary morphological characters it resembles closely the species named, but there are important differences in the seedlings, the percentage of tannin in the bark, and other characters which lead the author to propose it as a new species. The type comes from Jerrabomberra, in the Federal Territory, near Queanbeyan.—E. **Cheel**: A native tea-tree, *Leptospermum flavescens* var. *grandiflorum*. This plant occurs in the deep creeks and river-beds from Penrith, extending to the Blue Mountains on the western line, and from Douglas Park to Braidwood on the southern line and tablelands. It was suggested that the plants were quite different from any other species, and the oil obtained from the leaves by Mr. A. R. Penfold tends to confirm this view.

Books Received.

The Foundations of Chemical Theory. By Prof. R. M. Caven. Pp. viii+266. (London: Blackie and Son, Ltd.) 12s. 6d. net.

A Physician's Anthology of English and American Poetry. Selected and arranged by Dr. C. A. Wood and Dr. F. H. Garrison. Pp. xxiii+346. (London: Oxford University Press.) 8s. 6d. net.

Les Hommes Fossiles: Eléments de Paléontologie Humaine. By Prof. M. Boule. Pp. xi+491. (Paris: Masson et Cie.) 40 francs.

Penrose's Annual. Volume 23 of the Process Year Book and Review of the Graphic Arts. 1921. Edited by W. Gamble. (London: P. Lund, Humphries and Co., Ltd.; Bradford: The Country Press.) 10s. 6d. net.

Personal Beauty and Racial Betterment. By Prof. K. Dunlap. Pp. 95. (London: H. Kimpton.) 6s. net.

Practical Dental Metallurgy. By Prof. J. D. Hodgen. Fifth edition, completely revised. Pp. 436. (London: H. Kimpton.) 15s. net.

Lubricating and Allied Oils: A Handbook for Chemists, Engineers, and Students. By E. A. Evans. (The Directly-Useful Technical Series.) Pp. xv+128. (London: Chapman and Hall, Ltd.) 9s. 6d. net.

Science Masters' Association: Oxford Meeting, January 5–6, 1921. Practical Suggestions towards the Study of Crystals in Schools. By T. V. Barker. (Oxford: The Holywell Press.) 1s. net.

Paläontologie und Abstammungslehre. By Prof. K. Diener. Zweite auflage. Pp. 137. (Berlin and Leipzig: W. de Gruyter and Co.) 1s. 9d.

The Theory of Direct-Current Dynamos and Motors. By J. Case. Pp. xiii+196. (Cambridge: W. Heffer and Sons, Ltd.) 15s. net.

An Introduction to the Chemistry of Plant Products. By Dr. P. Haas and T. G. Hill. Vol. i.: On the Nature and Significance of the Commoner Organic Compounds of Plants. Third edition. Pp. xiii+414. (London: Longmans, Green and Co.) 16s. net.

A Text-Book of Physics. By Dr. W. Watson. Seventh edition, revised by H. Moss. Pp. xxvi+976. (London: Longmans, Green and Co.) 21s. net.

Department of Applied Statistics (Computing Section), University of London, University College. Tracts for Computers. Edited by Karl Pearson. No. ii.: On the Construction of Tables and on Interpolation. Part i.: Uni-variate Tables. By Karl Pearson. Pp. 70. 3s. 9d. net. No. iii.: On the Construction of Tables and on Interpolation. Part ii.: Bi-variate Tables. By Karl Pearson. Pp. 54. 3s. 9d. net. (London: Cambridge University Press.)

General Practice and X-Rays: A Handbook for the General Practitioner and Student. By Alice V. Knox. Pp. xiv+214+xxxii plates. (London: A. and C. Black.) 15s. net.

The New Hazell Annual and Almanack for the Year 1921. Thirty-sixth Year of Issue. Pp. lvi+823. (London: H. Frowde and Hodder and Stoughton.) 7s. 6d. net.

Clouds: A Descriptive Illustrated Guide-Book to the Observation and Classification of Clouds. By G. A. Clarke. Pp. xvi+136+40 plates. (London: Constable and Co., Ltd.) 21s. net

The Raw Materials of Perfumery: Their Nature, Occurrence, and Employment. By E. J. Perry. Pp. ix+112. (London: Sir I. Pitman and Sons, Ltd.) 3s. net.

Diary of Societies.

THURSDAY, JANUARY 20.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. A. Harden: Biochemistry (Vitamines).

ROYAL SOCIETY, at 4.30.—Sir Robert Hadfield, Bart., S. R. Williams, and I. S. Bowen: The Magnetic Mechanical Analysis of Manganese Steel.—Dr. W. S. Tucker and E. T. Paris: A Selective Hot-wire Microphone.—E. A. Milne and R. H. Fowler: Siren Harmonics and a Pure Tone Siren.—Prof. L. V. King: The Design of Diaphragms capable of Continuous Tuning.

LINNEAN SOCIETY, at 5.—Prof. E. H. C. Walsh: Lhasa and Central Tibet.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.—Lord Montagu of Beaulieu: The Cost of Air Ton-miles compared with Other Forms of Transport.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—R. E. Palmer: Some Observations on Mining by the Opencast or Stripping Method.—E. A. Wraight: The Standardisation of Materials Employed in Mining and Milling Plant.—A. M. Pontic: Notes on the High-level Diamond Deposits of Brazil.

INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates' Meeting), at 8.—W. H. Wardall: Cylinder and Piston Wear.

CHEMICAL SOCIETY, at 8.—J. V. Backes, R. W. West, and M. A. Whiteley: Quantitative Reduction by Hydriodic Acid of Halogenated Malonyl Derivatives. Part I., The Amides of Sym. Dialkyl and Aryl Substituted Amides of Mono- and Di-bromomalonic Acid.—B. M. Gupta: An Investigation on the Influence of Negative Groups of Different Character on the Reactivity of Hydrogen Atoms Carried by the Same Carbon Atom. Part I.—J. Brönsted: The Influence of Salts upon the Chemical Equilibria in Solution.—H. Hepworth: The Action of the Grignard Reagent on Certain Nitric Esters.—G. T. Morgan and H. D. K. Drew:

Researches on Residual Affinity and Co-ordination. Part III., Reactions of Selenium and Tellurium Acetylacetones.—G. T. Morgan and D. C. Vining: Dihydroxynaphthaldehydes.—G. T. Morgan: Ortho-chlorodinitrotoluenes. Part II.—C. K. Ingold: The Conditions Underlying the Formation of Unsaturated and of Cyclic Compounds from Halogenated Open-chain Derivatives. Part I., Products Derived from α-Halogenated Glutaric Acids.—A. Findlay and W. Thomas: Influence of Colloids on the Rate of Reactions involving Gases. I., Decomposition of Hydroxylamine in Presence of Colloidal Platinum.—M. Nierenstein: The Constitution of Catechin. Part III., Synthesis of *aca*Catechin.—K. G. Naik: The Formation and Properties of Dithioketones ($R_2C=S=S$) and Dithioethers ($R_2S=S$). Part I., The Preparation of Certain Dithioketones and Dithioethers.—W. N. Haworth and E. L. Hirst: The Constitution of the Disaccharides. Part V., Cellobiose (Cellose).—S. H. C. Briggs: The Elements Regarded as Compounds of the First Order.—J. D. Morgan and R. V. Wheeler: Phenomena of the Ignition of Gaseous Mixtures by Induction Coil Sparks.—E. J. Williams: Chloroform Solutions of Hydrogen Chloride.—L. J. Hudleston and H. Bassett: Equilibria of Hydrofluosilicic Acid.—E. Newbery: Chlorine Overvoltages.—P. Rây and P. V. Sarkar: Compounds of Hexamethylenetetramine with Complex Metallic Salts and Acids.

RÖNTGEN SOCIETY (in Physics Laboratory, University College), at 8.15.—M. A. Codd: Increasing the Efficiency of X-ray Tubes by an Improved Design of Coil and Interrupter.

FRIDAY, JANUARY 21.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Prof. R. S. Troup: Indian Timbers.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.—T. R. Rodger: Cavernous Sinus Thrombosis.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Keith: The Principles of Craniology applied to Clinical and Racial Problems.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—H. J. Smith: The Mechanical Loading of Ships.

INSTITUTION OF ELECTRICAL ENGINEERS (at Faraday House, Southampton Row), at 6.30.—H. J. Howard: Electric Welding.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—G. Barrow: The Origin and Age of Post-Eocene Brick-earths near London.

JUNIOR INSTITUTION OF ENGINEERS (at Caxton Hall), at 8.—B. H. Joy: Motor Yachts.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Dr. W. J. Turrell: The Therapeutic Activity of the Galvanic Current.

SATURDAY, JANUARY 22.

BRITISH MYCOLOGICAL SOCIETY (in Botanical Department, University College, Gower Street), at 11 a.m.—F. T. Brooks: Some Tomato Fruit Diseases.—Dr. E. J. Butler: The Imperial Bureau of Mycology.—Miss G. Lister: A New Genus of the Mycetozoa from Japan.—T. Petch: Thread Blights.—Dr. H. Wager: The Action of Gravity on the Fungi.—J. Ramsbottom: Exhibit of Lantern Slides showing Fungal Infection of Orchid Seeds.

PHYSIOLOGICAL SOCIETY (at King's College), at 4.

MONDAY, JANUARY 24.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Keith: The Principles of Craniology applied to Clinical and Racial Problems.

ROYAL SOCIETY OF ARTS, at 8.—A. E. L. Chorlton: Aero Engines (Howard Lectures).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—Sir Frank Colyer: Old Dental Instruments.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—F. C. Cornell: The Lower Reaches of the Orange River.

MEDICAL SOCIETY OF LONDON, at 8.30.—Dr. A. Feiling: Multiple Neuritis.

TUESDAY, JANUARY 25.

ROYAL HORTICULTURAL SOCIETY, at 3.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Gerald P. Lenox-Conyngham: The Progress of Geodesy in India.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—Resumption of Discussion on paper by Prof. T. B. Abell on Reinforced Concrete for Ship-Construction.—G. Ellson: Cannon Street Bridge Strengthening.—F. W. A. Handman: Reconstruction of a Viaduct.

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.30.—Dr. P. J. Cammidge: Some Observations Bearing on the Etiological Classification of Diabetes Mellitus.—Dr. E. P. Poulton: The Treatment of Peptic Ulcer by Means of Gastric and Gastro-duodenal Tubes.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Dr. F. M. D. Berry: Serbia and Jugo-Slavia Before the War and After.

ROYAL ANTHROPOLOGICAL INSTITUTE (Annual General Meeting), at 8.15.

WEDNESDAY, JANUARY 26.

ROYAL SOCIETY OF ARTS, at 4.30.—A. Abbott: The Origin and Development of the Research Associations Established by the Department for Scientific and Industrial Research.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Keith: The Principles of Craniology applied to Clinical and Racial Problems.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—F. E. Wentworth-Sheilds: The Lay-out and Equipment of Docks (Vernon-Harcourt Lecture).

THURSDAY, JANUARY 27.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. A. Harden: Biochemistry (Vitamines).

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—K. Sassa and Prof. C. S. Sherrington: The Myogram of the Flexor-reflex evolved by a Single Break-shock.—Sir Almroth Wright: "Interaction" Between Albuminous Substances and Saline Solutions.—Dr. S. Russ, Dr. Helen Chambers, and Gladwys M. Scott: The Local and Generalised Action of Radium and X-rays upon Tumour Growth.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.30.—Dr. G. L. Pardington: Advancing Years and Balneotherapy (Presidential Address).

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—G. A. Juhlin: Temperature Limits of Large Alternators.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—T. Walker: Obstruction After Suprapubic Prostatectomy and an Open Operation for its Prevention.

FRIDAY, JANUARY 28.

ASSOCIATION OF ECONOMIC BIOLOGISTS (at Imperial College of Science), at 2.30.—Dr. L. Lloyd: Greenhouse White Fly and its Control.—W. B. Brierley: Personal Impressions of Some American Biologists and their Problems.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children), at 5.—Dr. P. Parkinson: A Case of Patent Ductus Arteriosus.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Keith: The Principles of Craniology applied to Clinical and Racial Problems.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—Prof. H. Nagaoka: The Magnetic Separation of the Neon Lines and Runge's Rule.—Capt. E. V. Appleton: A Method of Demonstrating the Retro-active Property of a Triode Oscillator.—Dr. D. Owen and R. M. Archer: The Quickness of Response of Current to Voltage in a Thermionic Tube.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.30.—Dr. A. S. M. MacGregor: Some Features of Current Small-pox in Glasgow.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir James Dewar: Cloudland Studies

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THURSDAY, JANUARY 27, 1921.

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University Appeals.

A FEW weeks ago announcement was made that in a lightning campaign the sum of 1,580,000*l.* had been obtained as a centennial endowment fund for McGill University, Montreal. The amount subscribed exceeded what the campaign was started to raise, and it included contributions of one million dollars each from the Government of the Province of Quebec and the Rockefeller Foundation.

There have recently been three similar appeals for funds for university institutions in this country; but, whatever may be the ultimate result, they have not yet been marked by the ready and overflowing aid rendered to McGill University. In October last the University of Birmingham appealed for 500,000*l.* to relieve the financial strain under which it is working, and in December the University of Leeds, as well as the University Colleges of Newcastle-upon-Tyne—the College of Medicine and Armstrong College—each asked for a like amount to enable them to adjust themselves to the conditions in which they have been placed by the devaluation of monetary standards, greatly increased expenses, and an overwhelming influx of students. Scarcely a single university can now meet its financial obligations, and all of them need additional funds to provide accommodation in the form of lecture-rooms and laboratories and new members of the teaching staff to bring the classes within reasonable proportions.

It is not generally realised outside university institutions how greatly the number of students in them has increased since the war. In the year 1912–13 the number of university students in the British Isles was roughly 27,000, or just under six per ten thousand of the population. At the present time the number is more than 40,000, and is approaching one per thousand of the population. There are about as many ex-Service men alone undergoing some form of higher education in universities and colleges, with the assistance of Government grants, as the total number of whole-time university students in these islands before the war. To some extent, no doubt, the increase represents an accumulation of students who were prevented by active service from taking the university courses they had contemplated; but even allowing for this, there is decided evidence that a growing desire exists for the highest and best education the country can provide.

The fees paid by university students can never represent more than a moderate fraction of the total income. In the year 1913–14 the total income of colleges and institutions of university standing in England in receipt of grants from the National Exchequer was about 700,000*l.*, of which 28 per cent. was derived from tuition fees and 34 per cent. from the State. In Welsh institutions 27 per cent. of the total income came from fees and 55 per cent. from the State. (At that time, therefore, the greater part of university education in England and Wales could have been freed from all fees by an additional sum of about 200,000*l.*) Details are not available to show similar proportions at the present time, but it is probably correct to say that students' fees provide about 30 per cent. of the income of university institutions.

This contribution is much higher relatively than that made by students in State-aided institutions in the United States. At Cornell University in 1914–15 the fees were 20 per cent. of the income; at the University of California 10 per cent.; and at Oklahoma only 2 per cent. On an average, the proportion of tuition fees to the incomes of our universities is at least three times that of like institutions in America. It would be unreasonable, as well as detrimental to the best national interests, therefore, to suggest that our universities might look for additional income by increasing the charge for the education provided.

The sources from which the necessary funds must be obtained are private benefactions, local authorities, or the Treasury. It must be confessed that with regard to the first of these we are far behind the New World. In the three years 1916–19 the universities of the British Isles received in gifts from private bodies and individuals a little more than one and a half million pounds—almost exactly the amount that friends of McGill University recently collected in the same number of weeks as the result of their appeal for further endowment. The benefactions to university institutions in the United States amount annually, indeed, to at least ten times what is received from private sources in our islands for like purposes. It cannot be said, therefore, that the field of private benefaction here has been exhausted, but only that it has not yet been stimulated into action as it has been in the United States. Whatever the reason, our millionaires, with few exceptions, have not shown that belief in higher education which is common across the Atlantic, and of which every week brings us further examples.

These are difficult days in which to extract support for higher education from local ratepayers, yet something might be done to adjust the charge more evenly in some parts of the country. County authorities often leave the boroughs in which university institutions exist to bear the greater part of the burden, though students from their areas partake freely of the advantages offered. The time has come when a complete survey should be made of the present position as regards the provision of higher education in all parts of the country, the habitations of the students, contributions of local authorities, and related matters. It might then be possible to secure equitable payment in rates for benefits received.

Failing substantial gifts from private benefactors, and with the ratepayer unwilling to add to his commitments, universities must turn to the Treasury for further support if they are to continue to exist. The Civil Service Estimates for 1920–21 included a total grant of 1,000,000*l.* to be paid out of the Exchequer for the maintenance of university institutions in the United Kingdom. This grant is inadequate to enable the universities to fulfil efficiently the duties which have been placed upon them. The bulk of the students—more than 25,000 out of 40,000—are ex-Service men receiving maintenance grants from the Government. The State has undertaken to provide for the training of these students, and the universities ought not to be left to face the financial difficulties in which they are involved chiefly because of the additional provision they have to make for means of instruction. Assuming the expenditure to be as economical as efficiency will permit, it would seem but an act of common justice for the Treasury grant to be increased to meet it while the ex-Service men are under training. While we trust that the recent appeals will meet with most generous support from rich citizens, we suggest that the State should also accept more fully its responsibility for the desperate condition in which many university institutions now find themselves.

The Theory and Practice of Psycho-analysis.

(1) *The Elements of Practical Psycho-analysis.* By P. Bousfield. Pp. xii+276. (London: Kegan Paul, Trench, Trubner, and Co., Ltd., 1920.) Price 10*s.* 6*d.* net.

(2) *Psychoneuroses of War and Peace: Thesis Approved for the Degree of Doctor of Medicine in the University of London.* By Dr. Millais Culpin. Pp. vii+127. (Cambridge: At the University Press, 1920.) Price 10*s.* net.

(3) *A Manual of Psychiatry.* Edited by Dr. A. J. Rosanoff. Fifth edition, revised and enlarged. Pp. xv+684. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) Price 22*s.* net.

THE subject of psycho-analysis is one that is looming very large on the psychological horizon at the moment, and as these three books have a considerable bearing on the matter, a few words on the general principles involved may not be out of place.

Meaning literally an analysis of the mind, the application of the term has come to be limited to a special technique originated and elaborated by Freud and his followers. It has long been known that the mind is capable of many activities which may be quite outside the consciousness of the individual concerned, and Janet, the French psychiatrist, pointed out that the curious losses of memory and other symptoms occurring in cases of hysteria were due to a splitting up or a dissociation of the mind. This dissociation was regarded as a purely passive disruptive process owing to the difficulty found by the individual in making a satisfactory adjustment to certain environmental factors. Freud, however, introduced the conception of an active process of splitting of the mind which he described as repression. His theory was to the effect that an unpleasant experience which, if retained in the memory, would disturb the equilibrium and peace of the conscious mind was liable to be repressed, and thenceforward to be retained in the unconscious mind with the limitation of being unrecallable to consciousness.

Such repressed ideas or memories still, however, had the power of influencing the stream of consciousness, and particularly if they were associated with the experience of a vivid, emotional reaction at the time of their original inception; it is as if the repressed idea took down with it into the unconsciousness a mass of emotional energy which, being unable to disperse through the consciousness by the normal channels of expression, remained a hidden focus of unrest and disturbance to the proper functioning of the mind as a whole. The technique of psycho-analysis was then adapted for the searching of the mind by a method of free association and by the examination of dreams so that the active repression was circumvented. The result was that the hidden idea, with its emotional attachment, technically a complex, was restored to the consciousness, and the emotion dispersed by proper expression and by the relief of the symptoms to which it had hitherto given rise.

Up to this point the mass of opinion is entirely in agreement as to the value of the Freudian conception, and the method of an unbiassed search for forgotten or repressed complexes by a psychological analysis of the mind is in common use by modern investigators in the subject. Unfortunately, however, Freud carried his theory to a stage to which a great deal of exception must be taken. He claims that all these repressed ideas are invariably associated with the experience of some sexual emotion, and by an ingenious system of thought he demonstrates conclusively to himself and his devotees that all experience is referable in terms of sexual satisfaction or dissatisfaction. Thus the sensations of the infant suckling at the breast are to be regarded as essentially sexual in their nature; the affection of a child for its parent is a manifestation of a homo-sexual tendency when it is directed to the similar-sexed parent, and is of hetero-sexual import if the affection be shown to the opposite-sexed parent.

Much use of the phenomena of symbolism is made by the Freudians in the interpretation of dreams as sexual representations, but for those readers who are interested in the matter, and who may look into some of the Freudian writings, it is only right to point out that a proposition such that the sexual organs of the male may be symbolised by any elongated object—*e.g.* a walking-stick, a Zeppelin, etc.—though quite defensible in the positive sense, may yet be quite indefensible when applied in the negative direction. Thus if a patient dreams that he has bought a new walking-stick, or that he is being chased by a Zeppelin, one cannot permit oneself to be satisfied with the deduction that here is undoubted proof of the sexual origin of the dream; yet on such grounds are many of the most advanced Freudian dogmas based.

Psycho-analysis, then, is the process by which all the symptoms and dreams of a patient are reduced to terms of sex, as opposed to the psychological analysis in which due regard is paid to the existence of other instincts, and bitter has been the conflict between the adherents of the two schools of thought. Of late there has been schism amongst the leaders of the psycho-analytic movement. Jung states that the sexual impulse is not the all in all of psychology, but that a more general "vital impulse" is at the root of all the trouble; Brill asserts that it is not the sexual instinct, but the fundamenal "desire for power" which, by its expression or repression, is the cause of all the psychological ills; Freud himself has said that there are other instincts, but that none but that of sex has yet been investigated. It may, therefore, be deduced that the psycho-analytic cult will gradually lose its virulence and a more rational view hold the field.

(1) It is, then, with no little surprise that one finds a book such as Mr. Bousfield's "Elements of Practical Psycho-analysis" being written at the present day. In his introduction the author says that it was written so that readers without any systematic study of psychology may easily grasp the psycho-analytic principles. This is a bad commencement; no one should attempt an examination of a debatable subject like this without some understanding of the modern views on the mind, and certainly no one should be allowed to practise the technique without a proper psychological training. However, apart from its aims, the book is purely a simplified and dogmatic child's version of the thorough-going Freudian views; the most indefensible assumptions are given as undisputed facts, and throughout the book only the sexual instinct appears to have any practical bearing on the matters under discussion. It is interesting to note that the author precisely dissociates himself from Freud on the very point of the acknowledgment of the existence of other instincts, which acknowledgment, as already stated, Freud has himself made; but the crowning feature of the book is the last chapter, in which the author attacks the Freudian acceptance of the theory of determinism. We hope that, for the sake of his own peace of mind, Mr. Bousfield will soon make the discovery that determinism has only a purely philosophic bearing on the question of psycho-analysis, and that a discussion on this point is out of place in an avowedly practical text-book. The last chapter, apart from the rest of the work, makes one wonder whether Mr. Bousfield does not belong, as do his anticipated readers, to the ranks of those who have had no previous systematic knowledge of psychology.

(2) It is with relief that one turns to a book such as the "Psychoneuroses of War and Peace,"

by Dr. Culpin. This is a work in which the Freudian conceptions are much used, but they are given in a manner which presents both sides of the case. Dr. Culpin is not childishly dogmatic; his reasoning is lucid and without partisanship; his results are given favourable or the reverse; and, above all, his book is enlightening. It makes one think for oneself whether one is a beginner or a scholar in psychology.

(3) "A Manual of Psychiatry," edited by Dr. A. J. Rosanoff, is, of course, a very different production from the two dealt with above. It is a comprehensive text-book, covering the whole ground of the field of mental disease, and, though one may not agree with it on all points, yet as a general text-book the subject-matter is handled very clearly, the practical details in the treatment of the insanities are sound, and the references indicate a careful and thorough familiarity with the writings of all the modern psychiatrists. A chapter is devoted to the Freudian teachings; they are inserted as excerpts from Freudian publications, no reference being made to the actual views of the author himself, or to any criticism which might be given. The chapters on the Stanford revision of the Binet-Simon tests for mental deficiency and the free association tests for use in analysis, with the very full "frequency of association" tables, are striking and useful innovations in a text-book of this kind.

The Teaching of Palæontology.

An Introduction to Palaeontology. By Dr. A. Morley Davies. Pp. xi+414. (London: Thomas Murby and Co., 1920.) Price 12*s.* 6*d.* net.

Invertebrate Palaeontology: An Introduction to the Study of Fossils. By H. L. Hawkins. Pp. xix+226+xvi plates. (London: Methuen and Co., Ltd., 1920.) Price 6*s.* 6*d.* net.

Palaeontology: Invertebrate. By H. Woods. Fifth edition. (Cambridge Biological Series.) Pp. viii+412. (Cambridge: At the University Press, 1919.) Price 12*s.* 6*d.* net.

IN pre-war days we were accustomed to rely overmuch on Germany for text-books of zoology and palæontology. In the latter science all that this country could show for fossil invertebrates was the useful examination-candidate's manual by Mr. Woods and one of the British Museum guides, which, though written for another purpose, was used as a text-book by some teachers. Now, thrown more on our own resources, we have not only a revised edition of the Cambridge book, but also a corresponding work from Dr. Morley Davies, of the Imperial College of Science, and a more general introduction by Mr. Hawkins, of University College, Reading. Apart from brief chapters on vertebrates and plants by Dr. Davies, each of these books deals only with invertebrates, so that it is easy to draw comparisons which may be profitable.

Mr. Woods and Dr. Davies both cater for university students, and both describe the phyla of the Invertebrata in succession, thus producing essentially zoological text-books, in which extinct forms take a predominant place. Mr. Hawkins deals rather with principles, not so much describing fossils as using them to explain the methods and conclusions of palæontological science. It is his book, not that of Dr. Davies, which really merits the title "An Introduction to Palæontology."

All the same, for the discipline of the schools it is the text-books that are necessary, and, while the value of Mr. Woods's method has been proved by an experience of twenty-seven years, we welcome the novel treatment by Dr. Davies. As becomes a teacher in the school of Huxley, he has introduced the more intensive study of selected types. In dealing with the Brachiopoda (with which, as the commonest of fossils, he selects to open), he does not, as does Mr. Woods, begin with the general anatomy of the phylum, but, map in hand, he guides his pupils to a pit in the Cornbrash and lets them collect those characteristic species *Terebratula intermedia* and *Ornithella obovata.* These are examined and their common characters noted; then closer examination brings out the points of difference, especially in the arm-loop. The features of these fossils are next elucidated by a study of modern forms, and on the way we are introduced to the conceptions of relation to environment, ontogeny, phylogeny, comparative morphology, chronology, and classification. At last the student, now or never thoroughly interested, passes to the systematic account, in which such common fossils as *Leptaena rhomboidalis, Productus productus, Conchidium Knighti,* and *Spirifer striatus* receive more detailed treatment. Is not this an admirable method? If only Dr. Davies had followed it more consistently throughout!

Both Dr. Davies and Mr. Hawkins deal with some technical matters of which students too often are left in ignorance. Such are the collection, preservation, and investigation of fossils, the rules of zoological nomenclature, and the terminology and nomenclature of rock-divisions and time-divisions. On these last thorny questions both authors are, in our opinion, sound, and these sections of Dr. Davies's book in particular should be an ever-present help to all working palæontologists.

Mr. Woods and Dr. Morley Davies are, as instructors of youth, chiefly concerned to get some facts into the heads of their pupils. They have not much space for philosophic discussion (what they have they make good use of), and none at all for that general talk which can brighten the way or inspire the reader to further effort. Whichever of them you choose to follow as guide, you will be well advised to take Mr. Hawkins with you as philosopher and friend. His drawings and photographs are admirable, and, considering the price of the book, are as much a credit to the publisher as to his own skill. They will greatly help the reader who has not at hand the more purely descriptive works, or whose acquaintance with fossils is not already that which seems demanded by some of the chapters. The chapter on materials explains the nature of fossils and distinguishes the various modes of preservation and their relation to different kinds of rocks. Thus it answers questions constantly asked by the casual finder of fossils. Is it, however, quite true that amber inclusa represent "the most perfect type of preservation"? Were this so, it should be possible to dissolve out the organisms and to remount them in a manner more convenient for study. He who attempts this will find that there is nothing to get out. What one sees in the amber is but an imprint—the ghost, as it were, of some insect, the material body of which has vanished. The preservation of chitin in some fine clays, as of the Oesel Eurypterus, is really more complete.

Again, to apply the term "cast" to an external imprint, and the term "mould" to an internal filling of some dissolved shell, seems to reverse the ordinary usage. Here Dr. Davies and Mr. Woods more nearly approach accuracy. There are four cases to distinguish: a single valve of a mussel may leave in the rock an external imprint or impression, and an internal imprint; the complete shell of a mussel or a snail, or the test of a sea-urchin, may have been dissolved away, leaving the complete external mould (from which a plaster cast can be taken) and the complete infilling of matrix (which is a natural cast of the interior).

The geological distribution and the succession of life-forms, which constitute the real basis of palæontology as an independent science, are attended to by Mr. Woods in paragraphs under the zoological divisions, and are summarised by Dr. Davies in a compact but clear appendix. Under the heading "Historical Biology" they make up the second half of Mr. Hawkins's book. Anyone who has attempted a similar history knows how hard it is to vary the phrasing, to bring out the broad masses, and to avoid a mere list of names. "Lucina and Corbis are common throughout the era. Cyclodonts are abundantly illustrated by Cardiidæ, Protocardia and Discors are especially frequent in the Eocene, Cardium itself is common in the Crags. Teleodonts are the predominant forms. Venus (pl. xvi., Fig. 1), Dosinia (pl. xvi., Fig. 2), Meretrix and Paphia have numerous species in the later Cainozoic; Tellina, Macoma, Psammobia and——" but, no! the pen denies its office. Let us rather turn back to the interesting chapters "Geological Palæontology" and "Biological Palæontology," where the author shows what light may be thrown by fossils on climatic and other conditions at diverse times and places, and on the problems of phylogeny, morphogeny, specialisation, degeneration, and orthogenesis.

The profound studies of Echinoidea by Mr. Hawkins entitle his opinions on those difficult questions to the utmost respect. But, dealing as we are here with educational books, we prefer to conclude with an opinion based on his successful work as teacher, an opinion with which examiners ought to agree. Recognition of species (fossil-spotting) should not be demanded of average students. "The chronological distribution of families and genera will give ample precision for elementary needs." "The most elementary student ought to know that Ammonites are not found in Cainozoic rocks; but he ought *not* to know the difference between *Dactylioceras commune* and *Peronoceras annulatum*. If the latter detail has been forced into his unprepared mind, some point of more general application and greater importance must have been omitted or ejected."

F. A. BATHER.

Sugar Technology and Fermentation.

(1) *The Sugar-beet in America.* By Prof. F. S. Harris. (The Rural Science Series, edited by L. H. Bailey.) Pp. xviii + 342 + xxxii plates. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1919.) Price 12s. net.

(2) *The Manufacture of Sugar from the Cane and Beet.* By T. H. P. Heriot. (Monographs on Industrial Chemistry, edited by Sir Edward Thorpe.) Pp. x + 426. (London: Longmans, Green, and Co., 1920.) Price 24s. net.

(3) *The Carbohydrates and Alcohol.* By Dr. S. Rideal and Associates. (Industrial Chemistry.) Pp. xv + 219. (London: Baillière, Tindall, and Cox, 1920.) Price 12s. 6d. net.

(1) THE beet-sugar industry in North America is of comparatively recent date, although it was undertaken nearly a century ago by men,

as the author remarks, "who had more enthusiasm than knowledge." It may now be said to be firmly established, thanks largely to the magnificent work carried out in the experimental stations of the United States Department of Agriculture. Prof. Harris has produced a compact and useful treatise on a subject which is of the greatest interest to us in the United Kingdom, and also to those in other parts of the Empire where the beetroot might be cultivated. The manufacture of sugar from beet presents numerous difficulties, and all who are interested in the subject would do well to study the present little volume. The text is clearly written, and the information it gives is concise and complete. A valuable feature is the list of books, periodicals, bulletins, and reports, in the English language, which is appended.

(2) Most teachers of specific branches of science prefer to write a book for the guidance of students in which the subject-matter is arranged in that particular manner and sequence to which they give preference. The book before us is one of that class. It is written by a sugar expert for the guidance of his students. We believe that Mr. Heriot is the only lecturer in Great Britain on sugar technology—a subject of such vast importance to the British Empire. The reviewer is the chairman of the Empire Sugar Supply (Technical) Committee, which issued a preliminary report in July, 1919. Information had been obtained from the Dominions, Dependencies, Colonies, and Protectorates of the Empire showing to date the production and consumption of sugar in the Empire, and the possibilities of increasing the production to such an extent as to render the Empire self-supporting as regards this commodity were considered. The report has been sent to members of the Government and to numerous other Members of Parliament and high officials. Up to the present, however, the only movement on the part of the Government has been the appointment of a committee of experts to visit India and report on the possibilities of extending sugar production in that part of the Empire.

The appearance of Mr. Heriot's book is a welcome sign that the teaching of sugar technology within the United Kingdom is now progressing. The problem of Empire sugar needs a sufficiency of trained scientific experts, for the industry is no longer one that can be left in the hands of rule-of-thumb workers. Its principles require a knowledge of agriculture, botany, chemistry, and engineering, which can only be gained at an institution such as that with which Mr. Heriot is connected.

The text of the book is divided into ten parts, covering well the whole field included under the title, whilst the numerous illustrations add much to its value. The first five chapters, dealing with scientific principles, cover but thirty-two pages, and they should certainly be extended in future editions. They are, by reason of their brevity, dogmatic rather than educational, and as an instance the opening chapter on the formation of sugar by plants may be cited. Nothing is said of plant respiration, whilst in the converse phenomenon, photosynthesis, formaldehyde is given as the first product. It is stated, without authority, that formaldehyde has been detected in minute quantities in the leaves of plants, but reference should have been made to a paper by Jörgensen and Kidd in 1917 in which it is shown that formaldehyde arises from chlorophyll in the absence of carbon dioxide.

Although a detailed description of analytical methods would be out of place in the present volume, chap. xv., covering twelve pages, is meagre—so much so as to make it of no value whatever. Under "reducing sugars," for example, the following may be quoted from the text: "A measured volume of Barreswill's (Fehling's) solution is diluted with water and boiled. The juice is then gradually added until the whole of the copper is precipitated as cuprous oxide. From the volume of the juice thus added, the reducing sugars per 100 of juice can be calculated."

The main portion of the book is devoted to technology, and here the matter is well chosen. Mr. Heriot has certainly added a useful volume to the literature of sugar manufacture, and one which was needed in our Empire, since it embraces the manufacture of sugar from both cane and beet.

(3) This book is one of a series the object of which is to give a "general survey" of industries "showing how chemical principles have been applied and have affected manufacture." "The subject," says the editor, "will be treated from the chemical rather than the engineering standpoint." The impossibility of giving more than an outline of the subject is admitted, but it is hoped to stimulate greater interest in certain industries to which the nation has paid insufficient attention.

Commencing with an introduction of fifteen pages dealing generally with the carbohydrates, cellulose, starch and its hydrolytic products, and the sugars, the remainder of the text is divided into six parts, each subdivided into sections. It deals with starch, dextrin, glucose, maltose, cane-sugar, beet-sugar, sugar refining, minor sources of sugar, caramel, malting, brewing, wine, potable and industrial alcohol, vinegar, acetic acid, acetone, and glycerin.

The task of writing such a book as that before us is no easy one, needing, as it does, the securing of collaborators having both practical and scientific knowledge of the various industries. Whilst it is not for us to criticise the qualifications of Dr. Rideal's collaborators, our reading of the book has led us to the conclusion that it is a condensed account of existing treatises rather than a succinct and original outline of the various chemical industries. References to the literature are given at the end of each part, and these, we submit, would have been better included in the text, so that the reader would know exactly where to find an expansion of any specific phase of the subject. References to journals such as that of the Society of Chemical Industry, without indicating definite papers, are of little use to those who are not specialists, but wish to glean further information on specific points.

The major portion calls for little comment on the score of accuracy, but there are some errors and mis-statements, and among them the following may be cited. Wheat is said in one place to contain 55–65 per cent. of starch, whilst in another place the average starch content is stated to be 68 per cent. The statement that the cheapest form of starch is that derived from the potato is inaccurate, and we can scarcely agree that wheat starch is used as a paste for bill-posting, etc. ! The title "Cane Sugar" and "Beet Sugar" for the sections dealing with the manufacture of sugar from cane and beet respectively might tend to revive the fallacy that sugar from the two sources differs. Goldthorpe barley is a broad-eared, not a narrow-eared, two-rowed barley; it belongs to the variety *Hordeum zeocriton*, not to *Hordeum distichum*. The statement that by the malting process "the insoluble starch of the grain is converted into soluble fermentable sugar" is one long ago exploded.

As a general criticism of this book, we regret being unable to come to any other conclusion than that the editor has failed to achieve his object. We hope that in the near future, with the collaboration of his expert advisers, he will recast the volume so as to eliminate errors and to give a clear and concise outline of the chemical industries dealt with.

ARTHUR R. LING.

Our Bookshelf

Magic in Names and in Other Things. By E. Clodd. Pp. vii + 238. (London: Chapman and Hall, Ltd., 1920.) Price 12s. 6d. net.

DEALING with the question of magic in names, Mr. Clodd expounds with interesting detail a chapter in folk-lore familiar to serious students, but well deserving treatment in a more popular form. His book is, in the main, a study of magic, or, to use the new word, "mana," "the sense of a vague, impersonal, ever-acting, universally diffused power" immanent in all things. His special subject, the name, is well defined in a quotation from Mr. Cornford which appears on his title-page: "Language, that stupendous product of the collective mind, is a duplicate, a shadow-soul, of the whole structure of reality; it is the most effective and comprehensive tool of human power, for nothing, whether human or superhuman, is beyond its reach." Hence the preliminary discussion of the mana in a man's hair or spittle, through which the magician can work evil against the owner, merges into a detailed consideration of the name. Evil can be worked against you by anyone who knows your name, and hence it is wise to have two names, one concealed, one for daily use. This leads to the more serious name of power, curses and charms, passwords and spells, the "mantram" of the Hindu, by means of which even the gods themselves can be coerced. The Mohammedan knows the Ninety-and-Nine Names of Allah, and by repeating them over and over again for days he gains magical power. This exposition, always clear and impressive, even if at times the religious views of the author are disclosed with undue emphasis, is supported by an accumulation of interesting facts drawn from a wide range of study of the thought of primitive peoples and of popular belief throughout the world. Folk-lore, as an expression of primitive psychology, has too long remained the possession of the expert, and any attempt to popularise it is welcome. This is Mr. Clodd's achievement, and his exposition of this chapter of popular belief proves the value of the study as a key to unlock the mind of man, which no historian or sociologist in the future can safely neglect.

The Civil Servant and his Profession. Pp. viii + 124. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) Price 3s. 6d. net.

THE Society of Civil Servants has organised a series of lectures on various aspects of the profession, and the book under notice contains five of the lectures which were given in March last, with an introductory address by Sir Cecil Harcourt Smith. The first lecture, by the late Sir Robert Morant, deals with the administrative side of the Civil Servant's profession; the second, by Lord Haldane, with the legal aspects; the third, by Sir Sidney Harmer, is on the subject of national museums and scientific research; the fourth, by Mr. E. F. Wise, treats of the relationship between the Civil Service and industry; and the last, by Mr. J. Lee, deals with the psychology of the Civil Servant. This collection of lectures will give the public some idea of the diversity, importance, and highly technical nature of the work which is performed by the staff of men and women who constitute the Civil Service.

The British Journal Photographic Almanac and Photographer's Daily Companion, 1921. Edited by George E. Brown. Pp. 840. (London: Henry Greenwood and Co., Ltd., n.d.) Price 2*s*. net.

THE sixtieth issue of this welcome annual appears only a week or two later than in pre-war time, and the edition is increased from 25,000 to 30,000. This indicates a gradual progress towards normal conditions. On the other hand, the volume is about seventy pages fewer than last year, and the price is increased. The obvious reticence of advertisers with regard to quoting prices, which we remarked on a year ago, still impresses one, though perhaps less strongly. The editor contributes a lengthy article on general photographic procedure which cannot fail to be of assistance to beginners. The usual "Epitome of Progress" is an excellent summary, extending to nearly 100 pages, of the notable events, business items, legal matters, novelties in apparatus and equipment (including raw materials used in photography), and new methods or modifications of them. After the extensive collection of formulæ follows "A History in Brief of Photographic and Photomechanical Processes," giving the year and sometimes the month and day of the chief events, beginning with Thomas Wedgwood's experiments, published by Davy in 1802. Of the other new matter, we are particularly glad to see that the editor has given a table which he calls "Corresponding Focal Powers and Focal Lengths." The focal powers are given in diopters, and the corresponding focal lengths in centimetres and in inches. Many lens problems are so very much more simple when calculated in diopters instead of in focal lengths that we hope this table will be extended in next year's issue, and that there will be added to it a few simple instructions as to its use. C. J.

Physiology and Biochemistry in Modern Medicine. By Prof. J. J. R. MacLeod, assisted by Roy G. Pearce, A. C. Redfield, and N. B. Taylor, and by Others. Third edition. Pp. xxxii + 992 + 9 plates. (London: Henry Kimpton, 1920.) Price 42*s*. net.

A NOTICE of an earlier edition of this work appeared in NATURE of December 18, 1919 (p. 389). That a new edition should be required in a year's time shows that the book has been found to meet the purpose for which it was written. The opportunity has been taken to recast the section on the nervous system, which has been excellently done by Dr. Redfield adding to it an account of the fundamental principles of the physiology of muscle and nerve. These changes will add to the value of the book to those for whom it is primarily intended, particularly to the medical man who wishes to apply advances in physiology to his clinical practice. Recent work on such questions as the effects of deficient oxygen supply, on "vitamins," on the capillary circulation, and on wound shock has been duly incorporated. A good account of the problem of the carriage of oxygen and carbon dioxide in the blood, still a disputed one, will also be found. Although the price of the book seems rather high, it may reasonably be held that good value is obtained. It might be worth consideration, however, whether the omission of some of the coloured plates would not enable a wider circulation to be ensured by a lower price. The further such knowledge as that contained in the book is spread, the better will it be for the advance of medical science and practice. W. M. B.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

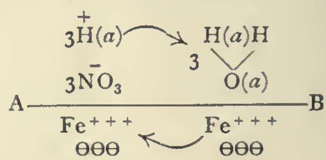
The Passivity of Metals.

CHROMIUM, iron, cobalt, nickel, copper, and bismuth are said to exhibit the phenomenon of passivity. These metals have electrode potentials varying from about Fe = +0·06 to Bi = −0·67 volt—that is, they are not very electro-positive. They also all exhibit dual valencies. This suggests that passivity may be due to an electrical double layer on the surface of the metal, especially when it is remembered that an anode of iron becomes passive in nitric acid of sufficient concentration.

The chief theories of passivity assume that a layer of oxide, nitride (St. Edme, *Comptes rendus*, vol. lii., p. 930, 1861), or gas is formed on the surface. St. Edme's view is founded upon the fact that ammonia is formed when passive iron is heated in dry hydrogen. But Finkelstein (*Zeit. phys. Chem.*, vol. xxxix., p. 91, 1901), from the results of his investigation of the polarisation capacity of passive iron, concludes that there can be no opaque layer on the surface, and he thinks that passive iron is ferric iron, whereas ordinary iron (active) is ferrous iron.

It is here suggested that passivity is produced by a layer of nitric acid or of nitrate ions firmly adhering to the surface of the metal. This view is not incompatible with either St. Edme's or Finkelstein's results. In fact, it seems as if there is considerable similarity between the surface of a passive metal and that of the disperse phase in a metal sol.

A consideration of the chemical forces yields the following model of the polarisation effects at the surface of a metal in an aqueous solution of an electrolyte, say iron in dilute nitric acid:



AB is the cross-section of a surface drawn between the liquid and the metal. Below AB is the Helmholtz electrical double layer, which we may conveniently regard as due to a layer of positive metal ions, and a layer of their valency electrons, two of which ions and their associated electrons are shown in the figure. The ions are represented in the ferric state, but this is not essential to the argument. Above AB, in the liquid phase, is a layer of molecules, which are polarised at a given moment in a regular surface lattice if the metal is pure. Obviously, the composition of this layer will depend upon that of the bulk of the liquid and upon the affinities of the iron ions for the nitric acid and the water. We may regard the nitric acid as ionised, but not so the water, because its ionisation is known not to be increased by the presence of dissolved electrolytes. Owing to the symmetry of the water molecule, it is impossible to say which H atom will break away and which will remain in the OH group in the event of ionisation.

Now it is highly probable that the chemical force, between ions even, is not wholly electrical, and we may assume that the nitrate ion and the water molecule will be attracted to their respective iron ions with forces which result in the setting up of an e.m.f. in the metal. If this e.m.f. is large enough, one of the metal ions will be discharged into the liquid momentarily as ferric nitrate, and in the model the atoms marked (*a*) will form water, the remaining H will be momentarily liberated, and positive current will flow as indicated by the arrows.

Two factors will make for passivity: a low electrode potential and homogeneity of the double layer above AB. Impurities in the metal will modify its electrode potential as well as the composition of the double layer. We find passivity a common property of the noble metals almost irrespective of the composition of the double layer, whereas with highly positive (active) metals passivity is never observed. In the case of intermediate metals passivity occurs only with certain kinds of double layers, and if these are unstable periodic action may result. Since the forces are not wholly electrical there is less chance for an electrostatic equilibrium—and consequent passivity—to be set up, and for this reason it seldom occurs with these metals.

A sufficient disturbance of the surface layer, by scratching, touching with a more electro-positive metal such as zinc, placing in a magnetic field, or heating, will, in conformity with experience, activate passive iron. It is significant that Smits and Lobry de Bruyn (Proc. K. Akad. Wetensch. Amsterdam, vol. xxi., p. 382, 1919) find that chlorine ions activate anodically polarised iron. Thus it seems that iron ions in the surface of the metal have a preferential affinity for Cl′ over NO_3'.

W. Hughes.

Bedford Modern School, January 10.

The Space-Time Hypothesis before Minkowski.

It is, perhaps, not generally realised that the theory of space and time, to which Minkowski was led on experimental grounds, had been formulated on general principles sixty-five years previously by Hamilton, the Irish mathematician. The point is, however, of interest, not merely as a question of priority, but for the insight it affords into the philosophic basis of the theory, as well as for the useful mathematical methods it suggests.

It is curious, therefore, that there should be a lack of recognition that the world of Minkowski is in all points identical with the system of quaternions of Hamilton, and that the latter mathematician specifically regarded this system as a four-dimensional expression of space and time, in which space bears to time the relation which $\sqrt{-1}$ bears to unity, time being the scalar part of the quaternion.

Quotations may be given from Hamilton's letters and manuscripts, cited in his "Life" by Graves, which leave no doubt on this matter.

Thus, vol. ii., p. 478:

"Let me suggest one leading thought, which will perhaps sound paradoxical, that time and space are imaginary, each with respect to the other. . . . Any expression for the peculiar relations of space in the forms of time, or for those of time in the forms of space, must therefore involve a seeming contradiction . . . it will be a 'mathematical imaginary.' This seems to me to be the clue, the secret of the matter."

Vol. iii., p. 635:

"The mathematical quaternion . . . in technical language may be said to be 'time *plus* space,' or 'space *plus* time,' and in this sense it has, or at least it involves a reference to, four dimensions."

In another place:

"My real is a kind of fourth dimension equally inclined to all directions of space."

Many other allusions will be found which prove that this idea was fundamental in the views of Hamilton, and that he held to it with the greatest tenacity, although there were at that period no experimental considerations to justify it, and although De Morgan and other mathematicians seem to have discouraged it, or ridiculed it. At the same time it does not appear that Hamilton has given an analysis of space and time which exhibits with sufficient clearness the concept of direction in space as being peculiarly attached to the symbol $\sqrt{-1}$, and the concept of positive and negative unity as being similarly connected with the two directions of time, towards the future and the past.

It is, however, easy to supply such an analysis, the clue being given by noting that to define a number by the equation $x^2+1=0$ virtually defines it as "a unit which cannot be differentiated from its own negative by any *qualitative* distinction."

It indeed appears to have been in the thought of Hamilton, as it must occur to anyone who considers the matter, that the connection between a root of the equation $x^2+1=0$ and a direction of space is to be looked upon as more than a mere symbolism; but the general philosophic bearing of such considerations on the whole nature of space and time is scarcely appropriate for discussion here. It may, however, be remarked that they indicate a point of view in which time and three-dimensional Euclidean space lose their apparently contingent character, and approach the necessity of the laws of arithmetic, of which they appear as a kind of derivative.

It should be added that practical advantage might be derived by mathematicians from the application of the methods of quaternions to the theory of relativity, for, besides offering a convenient mode of development of the geometry of four dimensions, either Euclidean or hyperbolic, according as Tq or $\sqrt{Sq^2}$ is taken as the element of length, they suggest important possibilities in connection with the inversion of a linear quaternion function analogous to the physical applications by Tait of the linear vector function.

E. H. Synge.

Dublin, January 6.

Heredity and Acquired Characters.

Will you permit a statement from a humble student? Between twenty-two and twenty-seven years ago, while in Malabar, opportunity was taken by me to ascertain whether the arms of rowers on the backwaters and the arms of the toddy-drawers were longer in proportion to the height than in the case of the rest of the population, for here seemed to offer a test whether "inheritance of the effects of use" was evident. In both cases the men belonged to a caste which had not changed its occupation for many hundreds, perhaps some thousands, of years: the former indigenous, while legend attributed the ancient home of the latter to Ceylon, where they were occupied in the same way—climbing and tapping the palm-trees for toddy. The stretch of arms in rowing demands no explanation, but it may be mentioned that the rowers were not engaged in rowing as they might be in England, but often continuously for long periods. Thus on first acquaintance they rowed (eighteen of them) forty-six miles to where I was, halted an hour or so to cook and eat a meal, and rowed back again the same distance, covering the ninety-two miles within twenty-four hours—not at all as a feat, but just in the ordinary way of work.

The climbing of the palms in this region needs some remarks, because whereas toddy-drawers are usually sustained by a strap round the back to ease the strain on the arms, in Malabar the whole weight of the body is borne by the arms alone, legs straight, feet held together by a grummet, the hands embracing the stem. Climbing in this manner is fatiguing, and when he has reached the top the climber works for about a quarter of an hour preparing the spathe, changing his pots, and so on, all the while upheld by the arms, which are thus on the stretch for a considerable portion of each day. It seemed, therefore, worth while to examine by careful measurements with instruments for anthropological work whether the continual straining of the arms during many generations affected the length of arms in relation to length of body-height. The result was that it did not. The arms of the hereditary rowers and of the hereditary climbers are no longer in proportion to height than of those engaged in occupations involving no strain of the arms. Writing far from home, I am unable to give you measures. FREDERICK FAWCETT.

Algiers, January 12.

Popular Science Lectures on Natural History.

THE lectures to juveniles at the Royal Institution by Prof. J. Arthur Thomson have been undoubtedly a great success, and I cannot help thinking that there are others, especially among our young men fresh from the universities, who could give lectures of this kind to popular audiences. If so, can they be discovered? They may be difficult to find, for success in this field requires a rare combination of gifts. It is absolutely necessary for such a lecturer to possess, besides knowledge and enthusiasm, a good voice and manner; his speech must be fairly loud, good, and clear, and his personality distinctly pleasing, or he will fail to win his audience. Unfortunately, few scientific men are good public speakers. It is also much to be regretted that many writers on biology and natural history adopt a style so learned and pedantic that both young and old are repelled.

Huxley, the younger Buckland, Gosse, and Hugh Miller are gone, and few follow in their steps. How sadly are the themes of beauty, mutual aid (so well treated by Kropotkin), and symbiosis neglected by modern writers! Those who do treat of these subjects seem to deal with them in a cold, dry way. The leading idea in Prof. Thomson's lectures is conquest by animals of the elements, and no other lecturer or writer has developed the subject as Prof. Thomson has done.

In conclusion, may I ask whether it would be possible to arrange courses of lectures on the same lines in different parts of London? It seems a pity that such lectures should be confined to the Royal Institution. Eager South London audiences can be found for Shakespeare's plays, and I believe good lectures on natural history would also appeal to such audiences, especially if well illustrated and well delivered.

H. NEVILLE HUTCHINSON.

Royal Societies' Club, January 10.

Anglo-American University Library for Central Europe.

IN connection with the above library, we are endeavouring to supply the various university libraries on the Continent with the scientific journals they urgently need.

Among the periodicals for which we have received a pressing demand NATURE is frequently mentioned, and I very much hope that you will be good enough to publish this letter in your columns so that any of your readers having copies of your journal from 1914 onwards may hear of our appeal. Any numbers of the periodical which readers may feel they can dispense with will be gratefully welcomed.

The library is entirely non-political and non-sectarian, its sole object being to enable humanity at large to benefit in the future, as it has done in the past, from the research of European scholars. Such research has been brought almost to a standstill from the fact that European centres of learning have been cut off since 1914, first of all by the blockade, and more recently by the exceedingly unfavourable position of the foreign exchanges, from English and American thought.

I fervently hope that some of your readers may be able to help in supplying the literary needs of Central Europe. A copy of the prospectus of the library will be gladly sent to anyone desiring a fuller account of its work and objects. B. M. HEADICAR,
Hon. Secretary.

London School of Economics, Clare Market, London, W.C.2, January 21.

Greenland in Europe.

WHATEVER lapse may be imputed to the London school-book of 1812, noticed by Mr. MacRitchie in NATURE of January 13, p. 647, it is not shared by the Rev. J. Goldsmith's "Geography, on a Popular Plan, Designed for the Use of Schools, and Young Persons," in its fifth edition at the earlier date of 1808. For that author, in a very interesting account of Greenland, at p. 46 remarks that many so-called "ice islands" "are to be met with on the coasts of Spitzbergen, to the great danger of the shipping employed in the Greenland fishery." He further instances the peril to which "Lord Mulgrave" was thus exposed in 1772, when by an opportune rising of the wind his ships, "after labouring against the resisting fields of ice, arrived at the west end of Spitzbergen." At this critical time, however, "Lord Mulgrave" was Capt. Phipps. T. R. R. S.

January 20.

Electric Light and Vegetation.

MR. PENDRED's interesting observations on the growth of vegetation beside the electric lights in the Cheddar caves (NATURE, vol. cv., p. 709, August 5, 1920) reminds me of some observations described by Mr. E. Cheel in the *Australian Naturalist*, vol. ii., 1912, p. 117. Of a number of plane-trees growing about Sydney railway station some were close to the large electric lights, and Mr. Cheel noticed that the branches nearest the lights retained their leaves from a month to a month and a half longer than the more distant branches of the same tree and than the trees distant from the lights. When the new leaves were opening in spring a similar period elapsed between the dates of opening of those near the lights and those distant therefrom, the branches subject to illumination being that much later in getting their leaves. THOS. STEEL.

Sydney, New South Wales.

The Sparrowhawk.

By J. H. OWEN.

THE sparrowhawk, in a perfectly wild state, is one of our most interesting birds to study. During the nesting period, and especially through the latter part of the incubation period and the whole of the nestling period, it is comparatively easy to observe and photograph the bird. With patience, photographs can be obtained at the nest of the birds, old and young, for something like a fortnight after the young have left the nest. This is because the cock, and in some cases the hen, deposit the kills on the nest, which becomes a larder to a large extent, and the young return to the nest for a meal whenever they are in need of food.

The young are helped to procure food and partly trained by the old birds for a still further period before they are finally dispersed to seek their own living. If the nesting period be considered to start when the building of the nest is begun, and to end at the dispersal of the young, it is of great length. I have seen new nests, practically complete except for the lining of the cup and a few minor details, as early as February 17. I usually search for new nests during the second half of March, and find quite a lot of pairs building them. Birds that do not start during March appear to use old nests of pigeon, jay, hawk, or even magpie as foundations, but they are in a minority in the neighbourhood of Felstead, in Essex, for at least three-quarters of the nests I find are entirely new. Of course, weather conditions have considerable influence on the building of nests; in rough, boisterous, or wet weather and on foggy days operations cease. In a forward year, such as 1916, complete sets of eggs may be found before the end of April; in a normal year it is unusual to find such sets until between May 14 and 21. The bird lays, as a rule, on alternate days, but occasionally there is a period of seventy-two hours between eggs, and sometimes even more. The full set consists of four to six eggs, rarely of seven or more. Very old birds produce fewer eggs, which are less heavily pigmented as the age of the bird increases, while the eggs of a young hen are not so evenly or so heavily pigmented, as a set, as are those of a fully mature bird.

The incubation period varies somewhat, but can be put at approximately thirty-three days. The eggs usually take a long time to hatch, even after they are chipped; it is quite usual for two whole days to elapse after the egg is chipped before the chick emerges—I have known this period to be as long as four days. This is probably because the eggs are not moistened by the hen, the shell is very thick, and the membrane very tough. I have often watched a hen helping a chick to break free from the shell. In such cases I have seen the hen eat the shells, but I feel convinced now that this is not the usual method of disposing of them. Usually they are carried some distance from the nest and dropped.

Like the chicks of all birds of prey, those of the sparrowhawk are covered with short, thick, white down when hatched, and their eyes are open; but the plumage does not show until the bird is more than fourteen days old. The nestling period is about twenty-eight days, and by the end of that time the young birds have mostly acquired their juvenile plumage; but the down does not finally disappear until they are some seven weeks old. During incubation the nest gets flecked with down from the hen, and is a beautiful sight just before incubation ends, if the weather has been good. If the first set of eggs has been taken, the second nest never gets anything like so well flecked; the supply is limited, and has been used up. This may be a survival of what still happens in the nests of ducks and geese. When the young are hatched, this down disappears very quickly; it is partly removed by the weather, but largely by the hen, which probably mistakes it for the feathers of victims. The nest is kept particularly clean all through the incubation and nestling periods until just before the young leave the nest. Then the nest again becomes beautifully and liberally flecked with down; but this time it is shed by the young birds.

When the hen begins to lay, she lines the bottom of the nest with bits of bark, touchwood, and dead leaves, and during the incubation period she adds material, sometimes to the rim and sometimes to the well of the nest, with the object of making the nest stronger and more comfortable. During the nestling period more is added, this time probably partly for sanitary reasons, to keep the young off material contaminated by contact with dead, and often decaying, victims. Dr. T. Lewis has even seen the cock bird bring twigs to the nest during the nestling period.

The hen, in my experience, does all the incubating, and usually the cock procures food for her. This she eats on the larger limbs of trees in the neighbourhood of the nest tree. The cock brings it to some position upwind of her and calls. If she wants it she goes to him and takes it, and they remain together a short time; then he goes away. If, after two or three calls, she does not join him, he flies through the nest tree calling; if she still takes no notice he goes to a favourite feeding-place, not very far from the nest as a rule, eats what he wants, and flies off again. The hen normally sits back to wind (Fig. 1). The proximity of an observation hut upsets her, and she will place herself as near back to wind as possible while keeping the hut still in view. If, however, it rains she will, hut or no hut, turn her back to it. If it rains hard she will gradually move her wings out from her body to cover more completely the well of the nest, and finally get such a spread on them that the primaries are parted, and each acts as a watercourse from her back and wings.

FIG. 1.—Incubating: normal position when easy in mind: very low in nest.

If it is very hot and the sun shines on the nest, she will get up from time to time and stretch or stand beside the eggs (Fig. 2). Sometimes she will preen herself, but she never stays off the eggs for long at a time. If she is very near hatching she will not relieve herself by more than a stretch, although she may be in agony from the direct rays of the sun. All she does is to rise slightly on the eggs and pant with her whole body.

For the first few days after the young are hatched she may be said generally to be covering them completely. As they get stronger and more vigorous they scramble from under her at will if the weather is fit. If it is raining, or the sun is directly on the nest, they have to go under cover. Later, when the weather is suitable, she may be on the nest, but the young may be all clear of her. At such times she will often shut her eyes and nod on the nest.

In wet weather she makes an umbrella of her body. She puts her back to the direction of the storm, the young collect, heads together, in the middle of the nest, and she shuffles over them. She usually opens and depresses her wings so far as the occasion demands. Of course, there are variations of position in this as in everything else. On one occasion, in a very heavy thunderstorm, the hen stood more between the young and the direction of the storm, and threw one wing over the young; then she gradually sank down until this wing was upheld by them (Fig. 3). In storms she usually crouches over the young, but gradually sinks lower until she is resting on them. Always, as she shuffles over them, she looks for the youngest nestling, and pulls it into the most protected position with her bill. Even when brooding is a thing of the past, the approach of a storm will bring her on to the nest very quickly, and she covers it immediately rain begins to fall. If she brings food to the nest she breaks it up first, but if the cock deposits food on the nest during the storm she takes no notice of it. When the storm passes away she will break such food up and then dry herself thoroughly on some branch from which she can watch the nest. She opens her wings and tail, and either faces the wind or has her back to it. She may get in a place where the sun can help the drying, but mostly she trusts to the wind. Sometimes her feathers are almost closed; at other times they are open to their widest extent; the amount of spread varies constantly. After drying is completed she preens herself thoroughly, pay-

FIG. 2.—Off the nest owing to sun: a pause and look round before returning.

ing particular attention to the flight and tail feathers.

Very interesting, too, is the sight of the hen making efforts to shield the young from the direct rays of a hot sun. When they are small enough for her to do so, she makes a sunshade of her wings and body that will protect them all. She first gets directly between them and the sun, and then she partly opens and depresses her wings, and moves forward until the young are completely in the shade. There she stays in a sort of crouch over them until the sun has moved behind some foliage. The whole time she is in great distress, for her entire body seems to pant, and her tongue works rapidly to and fro.

Fig. 3.—Brooding in heavy thunderstorm.

If the young are too big for her to shelter all of them completely, she does what she can. She gets between the sun and the middle of the nest, partly spreads her tail, and opens her wings slightly, standing with her feet apart. The young then take turns to make use of the shade her body affords (Fig. 4). She stays like that as long as it is necessary, and, as before, seems to suffer greatly from the heat the whole time.

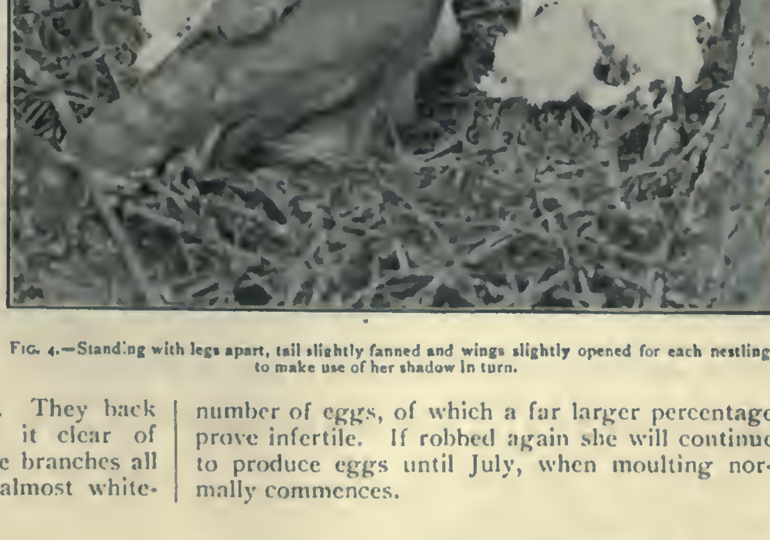


Fig. 4.—Standing with legs apart, tail slightly fanned and wings slightly opened for each nestling to make use of her shadow in turn.

The young do not foul the nest with excrement, so that the old bird has not to remove it. They back to the edge of the nest and eject it clear of the rim from a very early age. The branches all round and below the nest become almost white-washed during the nestling period unless rain comes to clear it away. When the nestlings are nearly ready to leave the nest, less care is taken about keeping it spick-and-span. They are able to feed themselves, and are allowed to do so. What bones they do not swallow are permitted to accumulate on the nest, and by the time the nest is finally deserted it may be covered deep with bones of victims, and many more bones will be found on the ground below the nest.

The cock is the procurer of food, but he takes no part in breaking it up. If the hen is killed during the nestling period he will continue to bring food so long as the nestlings are alive. If they are less than twenty days old they probably all die. If they are over that age they can tear enough food off to keep going, and the majority would survive. If the cock is killed, the hen perforce becomes the hunter, and provides food for the young and herself. I have heard, on very credible authority, that it is by no means uncommon in this case for the hen to get an unmated cock to help her.

There is only one brood in the year. A bird that is robbed lays again, but usually a smaller number of eggs, of which a far larger percentage prove infertile. If robbed again she will continue to produce eggs until July, when moulting normally commences.

The Institute of Human Palæontology, Paris.

ON December 23, 1920, the Institute of Human Palæontology in Paris was formally declared open by His Serene Highness Prince Albert of Monaco, its founder. The interest and active participation of the Prince in more than one branch of research have long been highly appreciated by the scientific world. The study of marine biology and oceanography already owed much to his valuable assistance and support when, more than twenty years ago, a visit to the Grimaldi Cave at Mentone first turned his attention to prehistoric archæology. Since that time all the more important cave explorations in Southern France and Northern Spain, which have enabled French archæologists to throw a flood of light on the character, art, life, and environment of prehistoric man, have been carried out under his auspices, at his expense, and frequently on lines suggested by him, while he has been responsible for the publication of the results in a manner and with a wealth of illustration which are not likely to be surpassed. Now, by the foundation of this institute as a headquarters in France for the systematic investigation of problems related to the origin and development of man, the Prince of Monaco has ensured the prosecution of this branch of scientific research in the most favourable conditions.

The Institute of Human Palæontology is situated in the Boulevard Saint Marcel. The building, which was nearing completion when war broke out, contains a large amphitheatre for lectures and meetings, a spacious library, and a number of rooms fitted up as laboratories, for examining and photographing the material furnished by excavation. Collections of specimens from the sites which have already been explored, as well as reproductions of the paintings and drawings found on the walls of the French and Spanish palæolithic caves, are exhibited in the building. An endowment of two million francs is attached to the Prince of Monaco's foundation, and an additional sum has been promised should it be rendered necessary by any further increase in the cost of living. The institute is under the direction of M. Marcelin Boule, assisted by a council consisting of MM. Salomon Reinach, Dislère, Verneau, and Louis Mayer.

FIG. 1.—The Institute of Human Palæontology. Front elevation.

Among those who were present at the opening ceremony were the President of the French Republic, M. Millerand, H.I.H. Prince Roland Bonaparte, M. Honnorat, then Minister of Public Instruction, the Belgian and Italian Ambassadors, the Argentine and Persian Ministers, M. Lacroix, secretary of the Academy of Sciences, the president of the Academy of Medicine, and representatives of the College of Medicine, the Collège de France, the Pasteur Institute, and the various scientific societies.

An inaugural address was delivered by the Prince of Monaco, in which he defined eloquently the broad aims of human palæontology. It was, he said, the prehistory of humanity. Only a few years had elapsed since men of science had recognised human handiwork in flints embedded in geological strata, and had seen in them man's first attempts at fashioning weapons for the chase and for defence. On these stones had been based a science which revealed our past and freed our judgment from the power of baseless philosophies and superstition. Investigation which traced the human species back to remote epochs revealed its relation to the animal world, from which it seemed slowly to have evolved. The prehistory of man began at that point when the human family was distinguished from other animals by a development of the brain which enabled it to diminish the part played by the muscles, and to employ moral force to carry on the struggle for existence: an artificial weapon took the place of the natural weapon, while, as shown by the paintings and drawings of the caves of Spain and Southern France, man was already capable of æsthetic emotion and sentiment.

FIG. 2.—The Institute of Human Palæontology. Sculptured group. Negresses and dead orang-utan.

FIG. 3.—The Institute of Human Palæontology. View of library showing bison killed by the Prince of Monaco.

The lesson of the history of mankind was, on the one hand, that man, though favoured by the laws of the universe, was still nothing more than a plaything in the hands of the forces of Nature; on the other, it helped us to surmount the bounds of a narrow philosophy which would reject all idea of relationship between man and the other members of the living world, and would wish to debar us from a study which placed mankind in an appropriate rank in the life of the globe. In the Prince's own words: "C'est pour aider l'Anthropologie à franchir les barrières qui la séparent de la vérité complète que je fonde l'Institut de Paléontologie humaine en lui donnant toute l'indépendance nécessaire pour conduire notre esprit vers la lumière. Et je confie ses intérêts à des hommes qui servent la Science avec une sincérité capable de développer sa force et de protéger sa marche contre l'influence des interventions passionnées."

At the conclusion of the Prince's address, brief speeches were made by M. Honnorat, Minister of Public Instruction, M. Perrier, and M. Le Corbeiller, president of the Municipal Council, the last named speaking on behalf of the city of Paris. Lastly, M. E. Cartailhac, the veteran archæologist, expressed his joy at the creation of the institute, which, he said, had been his dearest wish throughout his career as an archæologist.

The Institute of Human Palæontology is the materialisation of a conception of the aims and methods of prehistoric archæology formed by the Prince of Monaco when first he turned serious attention to the subject. It is, in a sense, a pendant to the institute he has founded for the study of oceanography, for, as he said in his inaugural address, "L'Océanographie, qui embrasse les origines du Monde, m'a rapproché de l'Anthropologie qui renferme les plus profonds secrets de l'Humanité." The reward which the Prince will seek for his munificent benefaction will lie in the results which may be expected from the facilities for study and research which he has placed at the disposal of science; but this reward will in itself be only a further addition to the debt already owed to him by archæology. His Serene Highness Prince Albert has indeed erected "a monument more lasting than brass."

Obituary.

DR. J. B. CROZIER.

DR. JOHN BEATTIE CROZIER (born at Galt, Canada, on April 23, 1849; died in London on January 8) was a thinker who knew how to combine philosophic breadth with scientific substance. His first master in speculative thought was Herbert Spencer, but he soon began to deviate from what he took to be the materialistic outcome of Spencer's psychology. The fault he found was that Spencer, in investigating mind, failed to view it adequately except from the objective side, as correlated with the brain and nervous system. This correlation itself Crozier accepted in the most thoroughgoing way; but, as the body is an organic unity, so also, he held, must the mind be unitary; and, by introspection, he found a "scale in the mind," not unlike that of the Platonic psychology, though it was for him an independent discovery. In this scale, truth, beauty, and love are at the top; such feelings as honour, ambition, and self-respect in the middle; and such qualities as greed and, in general, animal appetite at the bottom. This led Crozier to a metaphysical doctrine (though he was inclined to repudiate the term metaphysics) according to which the higher attributes of mind are superior not only in quality, but also, correspondingly, in ultimate strength.

What this scale or order in the mind points to, though it does not actually prove it, is dominance of the universe by a Supreme Intelligence. This view Crozier arrived at early, as may be seen in some extremely interesting chapters of "My Inner Life" (1898), and preserved to the end, as is set forth in "Last Words on Great Issues" (1917). It did not amount, he frankly admitted, to a religious creed. Having no mystical turn, he set to work in a scientific spirit on the investigation of human history, where, if anywhere, verification might be expected. The clue was the newly demonstrated theory of biological evolution, in which his master was Darwin. In the history of civilised peoples, on a wide survey, he found laws of progress; and these he made it his purpose to bring out in his central and best-known work, "The History of Intellectual Development."

In this and his other books, which grouped themselves naturally around it, Crozier carried out with approximate completeness, with literary interest diffused over the whole, and in the end with considerable acceptance on the part of the public, the scheme he had set before himself in the beginning. Presiding over his studies of historical evolution was his other great leading idea, that of social consensus—no doubt more vividly realised through his occupation with the profession of medicine. As the individual mind, like the body, is an organic whole, so is a society considered mentally as well as in its physical interconnection; and, apart from society, the individual is unintelligible.

Quite rightly, in his latest book, Crozier claims to have anticipated much recent development of a general theory which he had already styled the "doctrine of the herd." His versatility went along with a capacity for close study and a gift of illumining social observation; and where he was not an expert he was ready to be corrected by experts.

BY the death of MR. EDMUND J. SPITTA on January 21, at sixty-eight years of age, microscopical science has lost another earnest student and exponent. While in general medical practice for many years, Mr. Spitta found time to contribute to more than one branch of microscopy, and his retirement to Hove several years ago enabled him to devote the remaining years of his life to the subject. He took an active part in the proceedings of the Quekett Microscopical Club, of which he was a past-president, and of the Royal Microscopical Society, of which, as well as of the Royal Astronomical Society, he was a past vice-president. Mr. Spitta made some contributions to the subject of pond life, but it was particularly photomicrography and the optics of the microscope to which he directed his energies. So far back as 1898 he published, in collaboration with Mr. Charles Slater, an "Atlas of Bacteriology" containing more than a hundred plates of photomicrographs of bacteria. More recently he brought out his "Photomicrography," and many of his photomicrographs of diatoms are of great excellence. His book on "Microscopy," the third edition of which was published last year, is a general treatise on the construction, optics, and use of the microscope. To the Royal Microscopical Society Mr. Spitta contributed in 1911 a note on Winkel lenses and oculars and a report on the value of some Grayson's rulings, the latter entailing a considerable amount of work, and in 1913 he reported on a collection of lenses and other optical apparatus made by Joseph Jackson Lister, the father of Lord Lister, and presented to the Royal Microscopical Society on the death of the latter.

WE regret to learn of the death of PROF. FRÉDÉRIC HOUSSAY, professor of zoology at the Sorbonne since 1904, and dean of the faculty of science since 1919. Houssay's first piece of work, done under the direction of Lacaze Duthiers, was on the operculum and pedal glands of gastropod molluscs, and he presented this as a thesis for his doctorate in 1884. The same year he left for Persia as a member of the Dieulafoy mission, and returned in 1886. Soon afterwards he began a series of studies in vertebrate embryology, of which perhaps the best known is his contribution to the discussion on the vertebral nature of the skull (1890). After following the development of the skull of axolotl, he supported the view that the skull is segmental and represents ten segments. Houssay next turned to the study of dynamical morphology, and published on this subject two important works, "La forme et la vie" (1900) and "Morphologie dynamique" (1910). He devoted special attention to the functional significance of the form of the body, tail, and fins of fishes, studying the movements in relation to form and stability, and he published the main results in 1912 ("Forme, puissance, et stabilité des poissons"). Almost his last work was a continuation of the same line—a study of the flight of birds and the form of their wings, for which he made detailed measurements of 238 skeletons. We join with our French colleagues in regretting the loss of an ingenious worker and a courteous colleague.

WE regret to announce the death, on January 5, of CAPT. HAROLD STUART FERGUSON, at seventy years of age. Educated at Eton and Wimbledon, Capt. Ferguson passed into Woolwich and obtained a commission in the Royal Artillery, but after a few years' service in that corps he resigned his commission and sailed for India. He eventually became English tutor to the three Princes of Travancore, and when they no longer needed tutelage he was appointed second in command of the Nair Brigade of native troops maintained by H.H. the Maharajah of Travancore From that time until his retirement in 1904 he held various appointments under the Travancore Government, including the directorship of the Trevandrum Museum and Public Gardens, where his great love of animals and birds ensured the very careful management of the wild creatures kept in captivity. His collectors at the same time brought in valuable collections of animals, birds, and plants. While in India he was elected a fellow of the Linnean Society, and on his retirement he interested himself greatly in the Zoological Society's Gardens at Regent's Park, and some time before his death he was elected a member of the council of the society. A man of science, a keen sportsman, and a charming companion, Capt. Ferguson died much regretted by a host of friends.

THE death is announced of PROF. CARL TOLDT, who held the senior chair of anatomy in the University of Vienna for twenty-four years. Prof. Toldt was born in Tirol in 1840, and with him disappears almost the last of the great general anatomists—men who worked at comparative as well as at human anatomy. He was well known for his "Atlas of Anatomy," which appeared in 1896, and soon ran through seven editions. He contributed many papers to anatomical literature, the best known being those which treat of the morphology of the mandible.

Notes.

AT the meeting of the Royal Society on March 3 a discussion on isotopes will be opened by Sir J. J. Thomson.

A WIRELESS Press message from Moscow on January 21 stated that Prince P. Kropotkin had contracted inflammation of the lungs, and a fatal issue was feared. Prince Kropotkin's many friends in this country will be glad to know that a later telegram encourages hope of recovery, and says that his illness is apparently due to bronchitis.

SIR FRANCIS YOUNGHUSBAND, president of the Royal Geographical Society, announced at the meeting of the society on January 24 that the chief of this year's expedition to Mount Everest will be Col. Howard Bury, while the actual reconnaissance of the mountain will be in the charge of Mr. Harold Raeburn, who will leave England for India in March.

THE Galton anniversary meeting will take place on February 16 at the Connaught Rooms, Great Queen Street, Kingsway, London, W.C.2. The Galton lecture will be given by Dr. W. Bateson, at 8.45 p.m., on "Common Sense in Racial Problems," and will be preceded by the Galton dinner, for which tickets may be obtained at the offices of the society, 11 Lincoln's Inn Fields, London, W.C.2

THE Department of Scientific and Industrial Research announces that the Research Association for the British Jute Industry has been approved by the Department as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. The secretary of the committee engaged in the establishment of this association is Mr. Frank S. Cathro, 1 Royal Exchange Place, Dundee.

THE following lecture arrangements have been made in connection with the Royal College of Physicians of London:—The Milroy lectures (on "Respiratory Efficiency in Relation to Health and Disease") will be delivered by Dr. Martin Flack on February 17, 22, and 24; the Goulstonian lectures (on "Glycæmia and Glycosuria") by Dr. G. Graham on March 1, 3, and 8; and the Lumleian lectures (on "Some Points in the Etiology of Skin Diseases") by Dr. A. Whitfield on March 10, 15, and 17. The lecture-hour in each case will be 5 o'clock.

THE physiological laboratory in the central offices of the University of London at South Kensington, of which the director is Prof. A. D. Waller, appears to be in some risk either of extinction or of mutilation by removal to another site. The London County Council, possibly under misapprehension as to the present status of the laboratory, threatens to withdraw the grant hitherto made, while the Senate of the University requires the rooms in July for its clerical staff. If the grant ceases the laboratory is to be closed. If it continues, or funds are provided from another source, the laboratory is to be accommodated elsewhere than on its present site. A letter of protest from Sir E. Sharpey Schafer has been published in the *Times*, and resolutions in favour of maintaining the laboratory in its present situation have been passed by various bodies of physiologists. It would be unfortunate if a valuable centre for research were dismantled in order to find room for work which could so much more easily be done elsewhere.

WE trust that an immediate inquiry will be instituted by the Ministry of Agriculture and Fisheries into the alleged effect of the discharge of oil from motor-propelled vessels at sea, to which Sir Arthur Shipley has directed attention in the columns of the *Times*. According to the *Naturalist* for January, gulls, razorbills, and guillemots have recently been picked up along the Yorkshire coast dead or dying, their plumage so saturated with oil that they were unable to fly or dive. Moreover, sedentary forms of rock-pool organisms are dying, and the inshore fisheries suffering in consequence, codling, coalfish, and other species haunting the inshore rocks being very scarce this year. It seems possible that unless remedial measures are taken disaster may overtake our fisheries.

THE United States Department of Agriculture has just issued a Circular (No. 135) directing attention to the fact that unless fur-bearing animals are rigidly conserved, the time is not far distant when many of the more valuable species will be exterminated. That this is no alarmist's cry is shown by the fact that both trappers and fur-dealers have urged the Government to take immediate steps to promulgate protection in the form of a close season and the infliction of penalties for furs taken out of condition. It is suggested that State Game Commissions and agricultural experiment stations should promote the raising of fur-bearers such as foxes, skunks, and musk-rats, and that other species less amenable to captivity should be conserved in sanctuaries.

IN the Kelvin lecture to the Institution of Electrical Engineers on January 13, Sir William Bragg gave an interesting and luminous account of the way in which the study of the properties of the electron has led to a better understanding of the structure of the atom. His concluding remarks indicate that the improvements he has been able to introduce into his X-ray spectrometer have enabled him to establish the fact that the atoms have different properties in different directions. This supports the theories of Lewis and Langmuir that some of the electrons constituting an atom do not participate in the orbital motion about the nucleus which is characteristic of the electrons of the Rutherford atom, as developed by Bohr and Sommerfeld, but, on the contrary, are restricted to certain portions of the outer surface of the system, in which they describe small closed orbits and so produce magnetic fields which serve as bonds of attachment between atoms.

IN co-operation with the Anglo-Batavian Society, the University of London has made arrangements for an interchange of lectures on medical subjects between London and the Netherlands. The first lecture of the series to be given by Dutch professors was delivered by Prof. Wertheim-Salamonson, of Amsterdam, on January 17 at the Royal Society of Medicine, the Vice-Chancellor of the University of London presiding. The subject chosen was "Tonus and Reflexes," one to which the lecturer has devoted much attention. The chief point discussed was the participation in reflexes obtained normally, but especially in some nervous affections, of that remarkable state of shortening into which voluntary muscles can be put by certain conditions—a state in which no electrical changes are to be detected and, as it appears, very little, if any, chemical or thermal changes take place. The lecturer was inclined to attribute the phenomena to effects through the sympathetic supply of muscle. The next lecture will be given by Prof. Boeke, of Leyden, on February 16, the subject being "The Modes of Termination of Nerve-fibres in Muscle."

A DISCUSSION, in which a number of kinema experts participated, took place before the Illuminating Engineering Society on January 18 on "The Use and Abuse of Light in Studios for Kinema-film Production." The making of films by artificial light involves the use of illuminations vastly higher than those usual in ordinary lighting, and cases have been mentioned of alleged injury to the eyes of actors arising from exposure to very powerful lights at close quarters. The subject is being considered by the Ministry of Health Committee on the Causes and Prevention of Blindness, the chairman of which, the

Right Hon. G. H. Roberts, made a few remarks at the meeting. Eye-troubles have been attributed to the glare of the intense visible light from certain illuminants, and it has also been suggested that the presence of a high proportion of ultra-violet rays may be an influential factor. It seems evident that the region of the spectrum best suited to film production needs further investigation. Possibly ultra-violet rays of very short wave-length, such as may be liable to affect the eyes, might be excluded without prejudice to photographic effect. The view was expressed by several speakers that the use of very powerful unscreened arcs in studios is rarely necessary, and that the best results are obtained by adopting screening and diffusing devices yielding conditions resembling natural lighting. The Illuminating Engineering Society has prepared a list of queries for circularisation which should yield useful information on these points.

WE have received the following communication from the U.S. National Research Council:—Dr. Henry A. Bumstead, professor of physics and director of the Sloane Physical Laboratory at Yale University, and for the past half-year on leave from the University as chairman of the National Research Council of Washington, D.C., died suddenly on the train on the night of December 31 while returning to Washington from Chicago, where he had been in attendance at the meetings of the American Association for the Advancement of Science and affiliated societies. The following resolution was unanimously adopted at a special meeting of the Interim Committee of the National Research Council held on January 3: "That the National Research Council learns of the death of Dr. Henry A. Bumstead, chairman of the Council, with great sorrow and a profound sense of loss. Dr. Bumstead in his association with the Council had revealed to its officers and members not only a high capacity for administration and a most loyal fidelity to the aims and work of the Council, but also a sweetness of disposition and personal attractiveness which had won for him the devoted and affectionate regard of all his colleagues in the Council. In his death the Council and the scientific world lose a man of most eminent attainments, highest character, and lovable personality. The National Research Council extends to the bereaved wife and family its deepest sympathy and condolence, and wishes to express to them its full appreciation of the great value of the services which Dr. Bumstead rendered it in the period of his association with it and the great loss which it suffers by his untimely death. But may we all remember that 'that life is long that answers life's great ends.'"

PROF. E. WESTERMARCK publishes in *Acta Academiae Aboensis*, part i., an important paper on "The Belief in Spirits in Morocco," the result of several expeditions into that country. It is mainly concerned with an elaborate account of the Jinn or underground spirits which interfere in every phase of human life. Men have been taken to their kingdom or have cohabited with the Jinniya or female spirits. Prof. Westermarck describes in detail the nature and doings of these spirits, prophylactic measures adopted against them, remedies for troubles caused by them, and measures for bringing them under control. He disputes the views of Robertson Smith, who regarded the belief in them to be a survival of totemism; nor can they be regarded originally as the spirits of the dead. Prof. Westermarck regards the conception of the Jinn to be "a generalisation on a much larger scale. These spirits seem to have been invented to explain strange and mysterious phenomena which suggest a volitional cause, especially such as inspire men with fear; but Robertson Smith's theory that their special haunts are places most frequented by wild beasts cannot be accepted. In their present form their original home was Arabia, whence they migrated to Morocco, where the general scheme of belief was mixed up with the local animistic beliefs of the Berber tribes."

THE American Museum of Natural History has arranged for a third Asiatic Expedition in co-operation with the American Asiatic Association and *Asia*. The Chinese Government has been invited to delegate to the expedition men who have had preliminary instruction in various branches of science, so that they may assist and, at the same time, be trained in modern methods of scientific exploration. In return for such help and facilities a duplicate set of the collections will be deposited in Peking to form the basis of a Chinese national museum. To aid this, the American Museum undertakes to train selected Chinese in museum work. It is proposed that the field work shall last for five years. From headquarters in Peking parties will work in the interior of China, Central Asia, Manchuria, and Kamchatka. The zoological collections will help to furnish a hall of Asiatic life in the American Museum of Natural History, where are already the specimens obtained by Mr. R. C. Andrews, the leader of the first and second Asiatic Expeditions. In *Natural History*, the journal of the museum, Mr. Andrews dwells on the fragmentary nature of our knowledge of this region. Some exaggeration is allowed for in propaganda, but when Mr. Andrews says, in italics, "Knowledge of the fossils of Eastern Asia rests almost entirely upon the report on a small collection of teeth and fragmentary bones purchased in the medicine-shops of Tientsin and described by a German named Schlosser," then we recognise that several fragments of knowledge have failed to catch the eye of the writer.

REPORT No. 10 of the Industrial Fatigue Research Board forms a preliminary account of some of the investigations now being undertaken by Messrs. J. Loveday and S. H. Munro into the boot and shoe industry. A historical sketch of the industry is given, and a detailed description of modern processes follows. The daily variations of output of various groups of workers in five factories are then recorded. As in almost all other industries, the Saturday output was found to be low (sometimes only 77 per cent. of the average), but the chief interest of the observations lies in the comparison between the skilled workers with a large output and the relatively unskilled, who showed an output 10 to 50 per cent. smaller. It was found that the former maintained a much more uniform output, and usually they improved slightly from day to day until they reached their acme on Friday. The relatively unskilled workers, on the other hand, showed a more irregular output, which generally fell off after the second or third working day of the week, and sometimes after the first working day. Another section of the report affords striking evidence of the value of rest-pauses. A firm which desired to increase its output without adding new machinery determined to make the experiment of working the double presses with a team of three girls, each operative working forty minutes in each hour and resting twenty minutes, instead of with two girls working continuously throughout the day. In a short time it was found that the total output from the presses had increased 44 per cent., *i.e.* the girls were producing individually nearly as much as they had been able to do previously, but in two-thirds the time.

A COPY has reached us of the first number (January) of the *Journal of Industrial Administration*, the official organ of the Institute of Industrial Administration, which was founded in the spring of last year. The scope of the journal is, it is announced, to be wider than that merely of reporting the proceedings of the institute on the lines usual with professional societies; its editor indicates that his chief aim will be to make the publication "a medium for the pooling of the experience of those interested in the administration of industrial enterprises, so that it may serve the urgent purpose of assisting in the policy of practical education for members." A prominent feature is to be the special section devoted to the discussion by correspondence of the problems connected with industrial administration; the object of this section is to provide members resident in any part of the world with a medium for exchanging views on administrative questions affecting their occupation on an open platform, and in a manner which will, whilst assisting members individually, conduce to the greatest usefulness of the institute. Particulars are given of instructional courses, open to members and non-members, to be held in London; these courses begin on February 2, and deal with production estimating and production costing. The journal contains an abstract of an address on "The Industrial Question" given by Viscount Haldane, O.M., at the inaugural meeting of the institute held on October 23 last. The editorial offices have been established at 110 Victoria Street, S.W.1.

AN important paper by Lord Lovat on recent progress in British forestry appears in the Journal of the Royal Society of Arts for January 7. It begins with a short account of the movement leading to the passing of the Forestry Act in August, 1919, which created the Forestry Commission and empowered this body to expend 3,500,000*l.* in afforestation during the ensuing ten years. Lord Lovat further points out the part which private landowners should play in this great national work, and discusses at some length the relations between forestry and such subjects as hill pasture, land given over to sport, small holdings, and soldier settlements. The paper concludes with an authoritative statement of the operations of the Forestry Commission during its first year. A good beginning has been made; 69,000 acres of land have been acquired and extensive nurseries started, in which there are growing already 129,000,000 seedlings and transplants.

THE burning coal-seams that are a conspicuous feature in the coalfields of the western United States lead G. Sherburne Rogers (U.S. Geol. Surv., Prof. Paper 108–A) to remark that a pile of coal exposed to the direct rays of the sun would be liable to become heated and finally to ignite. From his observations in Montana he concludes that "the physical factors promoting spontaneous combustion are a finely divided condition of the coal, a slight increment of heat from an outside source, and a sufficient volume of coal to retard loss of heat by radiation." The absorption of oxygen by coal when warmed generates further heat, and the process is thus self-accelerating. Parr and Francis are quoted as showing that at 120° C. to 140° C. a critical stage arises, when the occluded oxygen combines with some of the hydrocarbons, producing carbon dioxide and water, accompanied by a rapid rise in temperature. Ignition occurs at 350° C. to 450° C. The fine dust of lignite, it appears, may ignite at 150° C., and of gas-coal at 200° C. The burning of coal-seams in the west is associated with the cuts formed by small and rapid streams. The metamorphic effects of the heat on the overlying rocks have been studied by the author, and include the production of spherulitic glass and of holocrystalline diopside-plagioclase slag.

THE November and December issues for the past year of the Journal of the Franklin Institute contain an important paper on the annealing of glass by Messrs. L. H. Adams and E. D. Williamson, of the geophysical laboratory of the Carnegie Institution of Washington. In order to supply the information demanded by the American glass manufacturers as to the proper method of annealing, the authors have determined the rate of disappearance of an initial stress in glass at any temperature. They find that the reciprocal of the stress increases with the time at a uniform rate which depends on the kind of glass and the temperature at which it is maintained. A table of rates for common glasses at various temperatures is given. As a result of their investigations the authors recommend that glass, and especially optical glass, should be annealed by raising the temperature in about 1½ hours to the value specified in one of the tables as suitable for that glass. This temperature is about 50° C. less than that in common use at the present time. The glass is maintained for four hours at that temperature and then allowed to cool, at first slowly, then rapidly, so that the cooling is over in about three hours, and the whole process lasts only eight hours. This is more effective than the old process, involving greater heating and slow cooling, which lasted twenty hours.

PARTICULARS have reached us of the Elmendorf paper-tester, which indicates the resistance offered by a sample of paper to tearing. A compound pendulum of weight P and equivalent length l is swung always from the same initial angle, and in the course of its downward swing it tears a suitably cut sample of paper held partly by a clamp secured to the pendulum and partly by the fixed support carrying the axis. The pendulum rises on the far side to an angle ϕ_1. When swung without tearing the paper it rises to an angle ϕ_2. The difference in the potential energy of the pendulum at the angles ϕ_1 and ϕ_2 is the work done in tearing the paper, and is equal to $Pl(\cos\phi_1 - \cos\phi_2)$. If the length of tear is d and the tearing resistance to be determined R,

$$R = \frac{Pl}{d}(\cos\phi_1 - \cos\phi_2).$$

In its present form the pendulum has the shape of a segment of a circle pivoted at the centre and calibrated round the circumference. It is held in its initial position by a spring stop. A light pointer mounted frictionally on the axis is set initially against the stop, where it is held until the pendulum commences its return swing; then it moves with the pendulum, and so the extent of the swing is recorded. The calibration can be such that R is read direct. The apparatus can be seen at the office of Messrs. R. J. Marx, 133–39 Finsbury Pavement, E.C.2.

AMONG the announcements of Mr. John Murray is "The Life of Alfred Newton," by A. F. R. Wollaston, in which the many activities of this former professor of zoology in the University of Cambridge will receive attention. The work will also contain a chapter describing Cambridge in the middle of last century, by Sir Arthur E. Shipley, and personal reminiscences of Prof. Newton by Dr. H. Guillemard.

ERRATA.—Dr. T. J. J. See sends the following corrections of values given by him in his letter on the measurement of the angular diameter of Betelgeux printed in last week's issue of NATURE, p. 663:—Lines 16 and 24, "orbit of Venus" should be "orbit of Mars." Lines 33–35 should read: "Sirius, which is itself twenty-fivefold more luminous than our sun. Accordingly, Betelgeux gives about 6500 times the sun's light."

Our Astronomical Column.

PONS-WINNECKE'S COMET.—The reappearance of this periodical comet is expected shortly, and the ensuing perihelion passage is likely to occur at nearly the same time of the year as in 1869, when it was on June 29, and in 1892, when it was June 30. On the former occasion the comet was first seen on April 9, and on the latter March 18. The following is an ephemeris:—

1921		Perihelion June 21 R.A.	Perihelion June 21 Decl. N.	Perihelion June 13 R.A.	Perihelion June 13 Decl. N.
		h. m. s.	° ′	h. m. s.	° ′
Feb.	3	13 26 10	19 8	13 45 16	17 8
	11	13 36 11	20 48	13 58 4	18 31
	19	13 45 32	22 51	14 11 0	20 17
Mar.	7	14 2 0	28 16	14 37 8	24 59

The date of perihelion passage is a little uncertain, so that for purposes of sweeping two series of positions are given, one on the assumption that it will occur on June 21 and the other on June 13. The comet will probably be rediscovered in February or March, and the meteoric shower connected with it, should it recur, may be expected on the night following June 27.

THE MAGELLANIC CLOUDS.—Dr. E. Hertzsprung has a paper on these clouds in Monthly Notices (vol. lxxx., No. 9). It is based on Mr. R. E. Wilson's measures of the radial velocity of nebulæ (Lick Obs. Pubs., vol. xiii.). On the whole, Mr. Wilson found low velocities for the gaseous nebulæ. There were, however, notable exceptions in the cases of seventeen nebulæ in the greater cloud, which showed average recessions of 276 km./sec., and one in the lesser cloud which showed 168 km./sec. It was a reasonable inference that the clouds were external to our galaxy; indeed, this was already thought probable on other grounds. On studying the individual motions it was seen that they showed a steady upward tendency as one went southward. Mr. Wilson suggested in explanation a rotation of the cloud; Dr. Hertzsprung points out that it is simpler to assume that the variation is a perspective effect, due to different parts of the cloud being at different angular distances from the apex of motion. He applies analysis to the observations, and finds as the most probable solution that the velocity of the greater cloud (corrected for the solar motion) is 608 km./sec. towards R.A. 4h. 31m., S. decl. 4° 42′ (galactic long. 168°, S. lat. 30°). The single nebula observed in the lesser cloud gives a result consistent with the two clouds having the same motion. The greater cloud is 63·7° from the apex, which gives a velocity of 560 km./sec. at right angles to the line of sight. Taking the distance as 10,000 parsecs, this implies an angular velocity of somewhat more than a second per century, the position angle being 348° and 55° for the greater and lesser clouds respectively.

It will be remembered that Dr. Hertzsprung was one of the first to give a trustworthy estimate of the distance of the clouds, based on methods quite similar to those applied later to the globular clusters by Dr. Shapley.

INVESTIGATION OF THE EINSTEIN SPECTRAL SHIFT.—Bulletin No. 64 of Kodaikanal Observatory contains a full account of a second investigation of this effect by Mr. J. Evershed. Mr. Evershed's former result (Bulletin No. 39) indicated considerably more than half the shift predicted by Einstein. In view of Dr. St. John's much smaller result, he planned a more extensive research, using the Anderson 6-in. grating, which was carried out in the spring of 1918. The spectrum of the sun both near the centre and near each pole was compared with the carbon arc. The results are corrected for solar and terrestrial rotation and the earth's radial velocity. The lines used are not the same as those of Dr. St. John, but the strongly marked triple carbon bands extending from 3876·59 to 3881·78. The mean values of the shift, sun *minus* arc, are:

Sun's centre ...	+0·0037 Å.
(omitting one discordant day)	
Sun's north limb ...	+0·0071 Å.
Sun's south limb ...	+0·0100 Å.
Einstein's value ...	+0·0082 Å.

Mr. Evershed notes that the late Mr. Pocock found a similar discordance between the measures at the sun's north and south limbs.

The Forestry Department of Edinburgh University.

SO far back as 1887 a lectureship in forestry was inaugurated at Edinburgh University. The courses given were mainly attended by students taking the University degree in agriculture. It was a far-sighted step to take at that time; since it is a great advantage to the scientific agriculturist to have some acquaintance with the aims and objects of the forester with whom he has so commonly to work side by side on the countryside. On the closure of the forestry branch at the Coopers Hill College in 1905, the training of the Indian forestry probationers was left in the hands of the universities. Recognising the altered conditions and the growing demand for the trained forest officer—for the Colonial Office was now beginning to require qualified men—Edinburgh University, which is pre-eminently a scientific and Empire university, instituted an ordinance for the degree of B.Sc. in forestry in 1909.

FIG. 1.—Forestry and Agricultural Building, University of Edinburgh.

Under this ordinance full courses in all the branches of pure forestry are given, and at least six months' practical work in forestry is required of the student for the degree. The subjects for the forestry Preliminary Examination for matriculation to the University are English, mathematics, Latin, and French or German, thus ensuring that the future forest officer shall have that acquaintance with modern languages which is indispensable to him.

During his first year the student takes the first science courses in pure science of the University in botany, zoology, natural philosophy, and chemistry. In the second and third years the forestry subjects proper, together with the allied science branches, including geology and surveying, are taken. In order to make full provision for the allied sciences, which form so important a branch of the training of the future forest officer, special lectureships in forest botany, forest mycology, forest zoology, forest engineering, and forest chemistry were inaugurated, as also a course in Indian forest trees. Students for the agricultural degree of B.Sc. have the option of taking the introductory forestry course, which is one of the courses under the forestry ordinance. More recently courses in tropical forestry and in Indian geology have been sanctioned. The fact that all the branches of applied science are dealt with by specialists in their individual subjects is of great importance in properly equipping the forest officer for his future life-work. In the past it has often occurred, both in Continental schools and in this country, that one lecturer was maintained, in order to save expense, to deliver courses in forest botany and forest entomology, with, perhaps, geology or another subject thrown in. The students' time-table for the degree is well filled up. The terms, three in the year, are of ten weeks each, and the hours, from 9 a.m. to 5 p.m. five days a week, are taken up with lectures, tutorials, and laboratory work. A part of most Saturdays is devoted to excursions, whilst the vacations are occupied, to the limit desirable in the interests of the student, with the practical courses in forestry.

In order to give full effect to the ordinance, the University had to make provision in the important question of buildings, laboratories, and so forth, and in this matter the department may claim to be second to none in the country. New buildings were erected containing a large lecture hall to accommodate 130 students, and several museums, including a sylviculture museum, a protection museum, a wood and economic products museum, and a museum for Indian and Colonial timbers. Then there are laboratories, a workshop fitted with a circular saw, a planing machine, and a lathe for the instruction of students, rooms for the members of the staff, a students' room, and a library. Additional rooms for the museum and laboratory of the lecturer in forest zoology were also provided in the building. These various parts of the building are fitted up with valuable collections of specimens, serving as object-lessons for the training of the students.

This accommodation was just completed before the outbreak of war. The site and building cost 19,500*l*., and at present prices it is easy to reckon that its value to-day is nearer 40,000*l*. than 20,000*l*. The equipment and fittings cost about 2000*l*., and the same remark applies to them. It is difficult to make even a guess at the value of the specimens which fill the museums. Towards this outlay, which is exclusive of museum specimens, the University furnished 15,200*l*., the Development Fund contributing 6300*l*. The other expenditure on the forestry department proper for the period of years 1910–11 to 1919–20, to which allusion is made, on salaries, etc., amounted to 8800*l*., of which 6600*l*. was furnished from the University funds and 2200*l*. from State funds; so that out of a total outlay during the period of 30,300*l*. the University provided 21,800*l*. as against 8500*l*. received from the State. In addition, the University paid from its own funds the salaries of the lecturers conducting the applied science subjects, forest botany, and so forth. Last year a chair in forestry was instituted and endowed within the University with the help of a grant from the Development Fund.

For the practical work, through the courtesy of their proprietors, Edinburgh University has had the use of the woods on the estates of the Duke of Atholl, Col. W. Steuart-Fothringham of Murthly, the Earl of Mansfield of Scone, and Viscount Novar of Novar and Raith, and of the Speyside Woods. The students are taken out to these areas and instructed in nursery work, in planting and felling, in sylviculture, and in the protection, utilisation, and scientific measurement of the woods. Arrangements have recently been made with the War Office by which a forest garden has been established on the War Office estate at Dreghorn, situated a few miles from Edinburgh, where a fine large nursery is being laid out; and the Stobs estate of several thousand acres, also belonging to the War Office, has been made available for practical work by the students, the University in return advising on the management of the woods of these estates. The Forest of Dean is used for advanced practical work, and the visits which were made to Continental forests before the war are now being resumed.

FIG. 2.—Protection Museum, Forestry Department, University of Edinburgh.

At the outbreak of war there were 50 students in the department; last year 168 students took forestry courses in the University, and this year the number has reached 170. The 40 students who have taken the forestry degree since 1911 are now serving in the Indian Forest Service and in the various Colonial Forest Services (South Africa, Canada, and New Zealand), in the Home Forestry Service, and in the Home universities. At the present moment there are in Edinburgh University sixteen Indian forestry, nine Colonial Office, and ten South African probationers—a total of thirty-five.

The University may thus be considered to have met a national need in placing itself in a position to give a full scientific training to the forest officers of the Empire.

The International Physiological Congress, 1920.

SUMMARY OF PAPERS.

SINCE more than two hundred papers and demonstrations were given at the above congress, which was held in Paris in July, a mere mention of the more outstanding communications is all that is possible in this summary. For a general account of the congress Prof. Fraser Harris's article in NATURE of September 16 may be consulted.

Of new apparatus, those described by Hess (Zürich) and Wilson (Cairo) may be specially mentioned. The former demonstrated a cardio-phonograph, a viscosimeter, and stereoscopic photographs. The latter exhibited a stethograph, a portable ergograph, a micro-nitrometer, a colorimeter, and a chronograph with electro-magnetic signal. The pursuit-meter described by Miles (Boston) for detecting the influence of nutrition, fatigue, industrial conditions, etc., on neuro-muscular co-ordination, and the demonstration (without the aid of the microscope) by Fredericq (Liége) of cilia, spermatozoa, etc., in motion, by means of intense illumination, were of particular interest. Philippson (Brussels) demonstrated an apparatus for showing the precise moment of coagulation of an organic liquid; another for recording modifications in the viscosity of fluids; and a method for measuring the electrical resistance of cells and tissues. The crescograph shown by Bose (Calcutta), which is claimed to magnify growth and other movements ten million times, was closely examined and much criticised. Mention may also be made of the display of well-made physiological apparatus by several French and Swiss firms.

Morpurgo (Turin) showed a number of artificially united rat-pairs (so-called Siamese twins). He finds that when two animals of different size are united the weaker dies from inanition, as a result of failure to hold its own in the joint distribution of nutritive substances. Rochon-Duvigneaud (Paris) finds that the foveæ in the retina of birds may be central, ex-central, or double; since complete decussation occurs at the optic chiasma, each has a unilateral connection. A communication by Minkowski (Zürich) dealt with the course of the optic fibres in man and other mammals.

Botazzi (Naples), by very slowly varying its temperature, finds that mammalian striated muscle (diaphragm) shows a distinct shortening at 0° C. (cold-contracture) and another, already well known, at 45° (heat-contracture). He believes that these changes, which are reversible, are due to the sarcoplasm. Heat rigor (63° C.), which is irreversible, he regards as due to contraction of the connective-tissue. Parnas (Warsaw), in his communications on muscle physiology, supported a view which is opposed to that of A. V. Hill on the question of the fate of lactic acid during the relaxation phase, favouring the combustion theory. Langley (Cambridge) suggested that muscle atrophy after denervation is due to fatigue (fibrillation), resulting from the irritation set up in the neural region of the muscle. He also spoke upon nerve suture and regeneration. The conditions of industrial fatigue were dealt with in a paper by Lee (New York).

The question of fat metabolism in its broadest aspect was the subject of a communication by Halliburton (London), the vitamine problem being specially considered. Gosset, Camus, and Monod (Paris) described a method for obtaining permanent biliary fistulæ in the dog. Both Foa (Parma) and Lombroso (Messina) dealt with the metabolism of fats in the liver; they showed that their destruction is much greater during digestion than during fasting. Lombroso also discussed the action of enterokinase upon the proteolytic activity of pancreatic juice. Brinkman (Groningen) showed that the cholesterol-phosphatide quotient controls the permeability of cell-membranes, those of erythrocytes in particular, and pointed out that this factor is all-important in the pathology of anæmias. The question of intermediary metabolites and their relation to heat production was dealt with by Graham Lusk (New York), who found that in the dog 58 grams of glucose increased heat production by 4·3 Calories, while 50 grams of glucose *plus* 8 grams of lactic acid caused an increase of 4·8 Calories. When lactic acid was replaced by 3 grams of acetic acid, the increase observed was 7·3 Calories. This last result is similar to that obtained when fat and glucose are metabolised together, and suggests that acetic acid may be an intermediary metabolite of fat, but not of glucose. E. and May Mellanby (London) showed that the cause of rickets is probably want of fat-soluble A vitamine in the diet. When this is lacking the development of bones and teeth is defective.

With intact kidneys a small dose of uræmic blood causes intense diuresis, while a large dose arrests the flow of urine. After denervation no result is obtained. This was demonstrated by Pi Suner and Bellido (Barcelona).

Macleod (Toronto) showed that in decerebrate cats the respiratory centre can be stimulated during slight anoxæmia without any decided change in the CO_2 tension or the H-ion concentration of the arterial blood; greater degrees of anoxæmia cause paralysis of the centre. Krogh (Copenhagen) demonstrated that the respiration of aquatic animals is not influenced by CO_2, but only by the amount of oxygen. The same author, employing the frog's tongue, finds that capillaries can be caused to dilate independently of the influence of the arterioles supplying the part. Waller (London) described a ready method of determining the CO_2 output under varying conditions of work; he also demonstrated the electrical emotive response in man. The effect of different kinds of exercise on the respiratory exchange in man was also dealt with by Liljestrand, Linhard, and Stenstrom (Stockholm), and as affected by gymnastic exercises by Langlois (Paris). The transport of CO_2 by hæmoglobin formed the subject of a communication by Buckmaster (Bristol). The crystallisation of hæmoglobin of the bat was described by Amantea and Kryszkowsky (Rome); these authors also dealt with the physiology of spermatozoa.

The glycogen-content of leucocytes and the nature of amœboid movement were discussed by de Haan (Groningen); amœboid movement is stated to be dependent partly on viscosity (colloid) and partly on HCO_3 ($NaHCO_3$). De Haan and Feringa produced evidence of the apparent formation of eosinophil leucocytes from lymphocytes. Doyon (Lyons) demonstrated that incoagulability of the blood after peptone injections is due to an antithrombic substance of nuclear origin—a nucleo-protein—containing 3 per cent. of phosphorus. Nucleinate of soda was also shown to be a strong anti-coagulant. Gautrelet (Paris) found no fatal effects or any alteration in the viscosity or the H-ion concentration of the blood after an intravenous injection of oil (1 c.c. per kilo. body-weight).

Sharpey Schafer (Edinburgh) proved that the pulmonary blood-vessels are supplied by vaso-motor nerves by showing that stimulation of the depressor nerve causes a fall in pulmonary pressure independently of the aortic system. He also exhibited cats in which both cervical sympathetics had been cut at an interval of a few weeks, showing paradoxical contraction of the pupil and dilatation of arterioles on the side of the first section. The mechanism of paradoxical dilatation of the pupil following cocainising of the cervical sympathetic was also discussed in a communication sent by Byrne (New York).

Feenstra (Utrecht) confirms the work of Zwaardemaker on the inter-availability of potassium and other radio-active salts in Ringer's solution. Dubois and Duvillier (Lille) showed that after section of the cervical cord double vagotomy may still produce cardiac acceleration provided the blood-pressure is sufficiently high. Wertheimer and Boulet (Lille) showed tracings to demonstrate that in frogs poisoned by $BaCl_2$ it is possible either to provoke or to arrest heart-block by an induction shock, according to the phase of the normal rhythm at which the heart is stimulated. Barry (Cork) showed in the toad's heart that reversal of action may take place (ventricle beating before auricle) during recovery from the effect of nicotine. Einthoven (Leyden) described experiments which appeared to show that the positive electrical change during vagal stimulation described by Gaskell in the tortoise auricle is due to mechanical stretching by contraction of the lung. De Boer (Amsterdam) reported the results of his study of the effects of varying rates of conduction on the form of the ventricular electrogram. He also described a method for obtaining delirium cordis in the frog-ventricle. Danielopolu (Bucharest) records observations upon the effects of various conditions—clinical and experimental—upon the human electro-cardiogram.

In a communication by Heger (Brussels) the cause of the relative hypertrophy of the right ventricle which occurs in man and animals acclimatised to residence at a high altitude is ascribed to a persistent pulmonary hyperæmia.

Anaphylaxis was the subject of communications by Kopaczewski (Paris) and Pesci (Turin).

Communications dealing with the central nervous system were few in number. Among them was one by Amantea (Rome) on the effect of application of strychnine to the sensori-motor region of the cerebral cortex on experimentally excited epilepsy; one by Camus and Roussy (Paris) on polyuria produced by lesions at the base of the brain; and one by Lafora (Madrid) on the functions of the corpus callosum.

According to Abelous (Toulouse), cholesterol is manufactured in the spleen, which organ may be stimulated to increased production in this direction by secretin. A paper by Rothlin (Zürich) was devoted to the effects of adrenalin and β-iminazolethylamine (active principle of secretin) on gastric secretion; the former inhibits, and the latter, if injected subcutaneously or intramuscularly, stimulates. Quantitative studies on the adrenalin output of the adrenal glands was the subject of a communication by Stewart (Cleveland). Bazett (Oxford), as the result of cross-circulation experiments, finds that adrenalin is of little importance as regards pressor reflexes, but that it functions by maintaining a normal tone in the arterioles or capillaries. Negrin y Lopez finds that after "piqûre" and double vagotomy the blood-pressure always rises, but if the animal has been adrenalectomised a fall occurs. Gayda (Turin) finds that tadpoles fed with thyroid give off more heat than normal ones.

Pézard (Paris) confirmed the experience of others that castration leads to the appearance of the opposite sex-characters in fowls. Athias (Lisbon) showed that after total castration pituitrin always contracts the uterus, while adrenalin does so only in the rabbit and hedgehog; it inhibits contraction of the uterus of the dog and cat.

There were also presented many communications dealing with problems of chemical physiology and with the action of particular drugs the contents of which do not lend themselves to a short summary.

R. K. S. LIM.

Liquid Fuel from Coal.

By PROF. JOHN W. COBB.

A PAPER entitled "Coal as a Future Source of Oil-fuel Supply," which has a very special interest at the present time, was read by Sir Arthur Duckham at a meeting of the Institution of Petroleum Technologists held at the Royal Society of Arts on October 19, 1920. It marks the recognition of a new state of affairs which is rising out of the enormous increase, actual and contemplated, in the use of liquid fuel and the by no means unlimited supply of natural petroleum. America is already concerned with the conservation of its own supplies of the latter, and there is every necessity for a careful and extended examination of any method which appears to be practicable for producing liquid fuel from solid deposits.

The demands that have to be met are of various kinds, and require products differing widely in the degree of their refinement. One extreme is encountered in providing for the delicate mechanism of the motor-car engine, and the other in meeting the grosser requirements of a steam boiler, particularly in the raising of steam for the propulsion of battleships and other sea-going vessels.

The Scottish shale industry is old-established, and an example of the practicability of obtaining oils by retorting, but the proved quantities of suitable oil-producing shale in this country are not very great. Sir Arthur Duckham has addressed himself to a discussion of what may be done by way of treating coal so as to obtain the best value in oils and tars. In reviewing possible lines of development he expresses the belief that the industrial future of this country lies in the conversion of the coal at the pit's mouth into liquid and gaseous fuels. "Liquid fuels will be recognised as the medium for providing energy for all transport by land, sea, or air with the exception of electrical transport for congested areas, while gaseous fuels will be used direct for the great majority of heating purposes and for the generation of electricity." He points out that "full experience has been gained in America of the transmission of gas over long distances," and then that "there is no question that, starting in the big industrial districts which lie near the coalfields, gas can be supplied in sufficient quantities and can economically replace solid fuel." In this way the author emphasises the production of gas, oil, and tar together from coal as being the right direction in which to go, and proceeds to discuss the various technical and commercial considerations which should influence the choice of process and plant for the purpose.

In this Sir Arthur Duckham is completely at home, and, although primarily a gas engineer of assured reputation, he displays no reverence for traditional and accepted methods when these appear to him to be only second best. He is, however, compelled to lament at an early stage the impossibility of supplying financial or thermal balance-sheets with any degree of confidence. This difficulty is inevitable at any time with unproved processes, and at the present time there are peculiar difficulties on the financial side which are not confined to the problem he is discussing, but apply to all schemes involving extensive reconstruction.

In order to deal in turn with established methods, the author reviews the position of gasworks, coke-ovens, and gas-producers. He describes the evolution of gas-making as it is conducted for the purpose of public supply, pointing out how "it started as a low-temperature process, and gradually became, with the improvement of materials of construction and advanced knowledge, a high-temperature process." He indicates the extent to which gas undertakings have been hampered by "antiquated and restrictive legislation," based upon the conditions of the past, and indicates quite rightly that the recent removal of these restrictions should make for rapid development.

The form of gasworks plant which meets with Sir Arthur's approval is evidently the continuous vertical retort with steaming, increasing the temperature about the bottom of the retorts and highly superheating the steam before it enters. The hot waste gases from the plant are to go through waste-heat boilers, so raising the quantity of steam required for steaming the retorts in return for a small extra capital expenditure and the cost required to drive the fan on the outlet boilers. The author points out in this connection what is so frequently ignored by the less informed advocates of low-temperature carbonisation, that in the continuous vertical retort a really fractional distillation can be attained. "The products of distillation are driven away as made, and have to pass through no higher temperature than that at which they are evolved, whilst if water-gas is made at the same time in the retort by steaming, this process protects the hydrocarbons and gives a greater quantity of a lighter quality tar." The weakness of gasworks practice, from the author's point of view, is that the coal has to be conveyed to the gasworks and the coke removed from it.

In dealing with coke-ovens it is argued that they meet a definite but limited demand for a specific article, namely, hard coke for blast-furnace work, and that on this account the erection of coke-ovens for supplying gas- and tar-oils to meet national needs is not feasible.

The author turns aside for a moment to indicate the possibility of using much more coke-oven gas for town supply, and points out that the chief difficulty in the way at present is the variation in its quality. That difficulty is not, however, insuperable.

He expresses, too, a belief that gas will in the future be used instead of coke in the smelting of iron-ore, but it is possible that in coming to that conclusion the high output and efficiency of a modern blast-furnace plant have not been taken sufficiently into account.

Sir Arthur does not regard gas-producers very favourably, though he admits their power of giving a large supply of heat-units in the form of gas at a low cost. His main criticism is that the tar-oils recovered are not valuable. "The condition in which they come from the plant makes them difficult to work up, and, according to the tar distillers, the final products do not compare at all favourably in value with the final products from other methods of destructive distillation of coal." In justice to the gas-producer it may be pointed out, however, that most of the criticisms under this head might be applied equally well to products of other processes of low-temperature distillation, and often mean simply that the tar is very poor in aromatic constituents, different from gasworks tar, and cannot be worked conveniently along with it.

In speaking of low-temperature carbonisation the author makes the pertinent observation that its advantages are too obvious. He goes on to indicate that the difficulties it presents are very real, and, of course, it cannot attain his ideal because so much of the fuel is finally left in the solid form.

The whole of these considerations and criticisms of the shortcomings of different processes have been leading up to a proposal of something different—total gasification in some form of plant which differs from a gas-producer in that air is not used for gasification of the fixed carbon, and, therefore, nitrogen in quantity is not present in the gas. "The principle of this process is the partial carbonisation of coal in a vertical retort superimposed on a water-gas generator, the retort being heated externally by means of the products of combustion of the producer during the blow period, and internally by the passing of the water-gas made up through the charge in the retort."

This comprehensive survey ends with the formulation of an ideal system of manufacture to meet the demands for liquid and gaseous fuels. It is to gasify coal completely, preferably in one vessel, recovering in a liquid form the maximum amount of volatiles in the coal (working with any coal) and preserving the resulting ammonia. It would be of the combined vertical retort water-gas-producer type, with recuperators, waste-heat boilers, and mechanical arrangements making for labour-saving and for high thermal and chemical efficiency. It is to the treatment in some such plant as this that the author looks for increasing our home-produced oil-fuel supplies, and no doubt he is willing to take his share in the skilful design and careful experimental work involved.

Sheep Panics.

A SHEEP panic on the night of December 10–11, in which the sheep broke their folds in twenty parishes in an area extending some twenty miles in the highest part of Cambridgeshire, has been attracting attention. These panics have often occurred, for sheep are notoriously timid and nervous animals. On November 3, 1888—an intensely dark night, with occasional flashes of lightning—tens of thousands of folded sheep jumped the hurdles and were found scattered the next morning. Every large farm from Wallingford to Twyford was affected, and those on the hill country north of the Thames most so. Again, on the night of December 4, 1893, another very remarkable panic among sheep occurred in the northern and middle parts of Oxfordshire, extending into adjoining parts of the counties of Warwick, Gloucester, and Berks.

Various causes for these panics have been suggested, but only one reasonable explanation has been satisfactorily adduced. The 1893 panic was, at the time, fully investigated by Mr. O. V. Aplin, who published in the Journal of the Royal Agricultural Society the result of his inquiries and the conclusions he drew from the extensive evidence collected. The conclusion arrived at was that the cause of the panic was simply thick darkness. Very few people, probably, have ever been out in a really dark night, and it is impossible for anyone who has not had this experience to imagine what it is like and the sense of helplessness it causes. That a thick darkness of this kind was experienced in the early part of the night of the recent panic (at a time agreeing with that at which, so far as was known, the sheep stampeded) was proved by abundant evidence. One report said that it was between 8 and 9 p.m. when such a thick and heavy darkness came on that a man could not see his own hand. Another witness wrote that a little before 8 o'clock there was an extraordinary black cloud travelling from north-west to south-east, which appeared to be rolling along the ground. The darkness lasted for thirty or forty minutes, and during that time it was like being shut up in a dark room. Later in the night—long after the panics—there were several flashes of lightning.

Mr. Aplin states that animals probably see perfectly well on ordinary dark nights, and we can imagine a bewilderment coming over them when they find themselves overtaken by a thick darkness in which they can see nothing. Folded sheep (and it was the small folds that the sheep broke most) in moving about would knock against their feeding-troughs and one another, and the first one that got a fright from this and made a little rush would probably come into collision with one or two others, and it would need nothing more to imbue the whole pen with the idea that there was some cause for fear. Then they would all make a rush, and their terror and the momentarily recurring incentives to, and aggravations of, it in the shape of collisions would only subside when the sheep had broken out and were in the open, clear of one another and of their troughs and hurdles.

If this is the explanation of the panic, then it is easy to understand why folded sheep are so much more likely to suffer than those lying in open fields. The heavy, oppressive atmosphere accompanying the thick darkness, the susceptibility of sheep to atmospheric disturbance, and their nervous and timid dispositions would all tend to increase the fright the sheep experienced. The cause of the panic being a cloud rolling along so low down as (apparently) to touch the ground, the tops of the hills and the high-lying ground would naturally be most affected; and this is observed to be the case, although locally the usual direction followed by thunderstorms has indicated a line along which sheep stampeded on nearly every farm.

The Work and Discoveries of Joule.[1]

By SIR DUGALD CLERK, K.B.E., F.R.S.

THE greatest generalisation in the early history of physical science was made late in the seventeenth century by Sir Isaac Newton when he enunciated the laws of motion and deduced from them the existence in space of attraction between planets and the sun. Mechanical science has been built up on Newton's fundamental propositions and discoveries. The discovery by Joule in the middle of the nineteenth century of the mechanical equivalent of heat and his suggestion and determination of the existence of an absolute zero, together with the adaptation of Carnot's cycle of 1824 to the theory of heat as a mode of motion, provide generalisations of equal importance to Newton's law of gravitation, and from them fundamental thermodynamic laws are deduced: the equivalence of energy in different forms, conservation of energy and dissipation of energy. Joule's discovery, in fact, called the modern science of thermodynamics into existence.

Manchester has been the home of many highly distinguished men—great scientific men, great inventors, and great masters of industry and business—but it is fortunate indeed in its connection with two of the greatest discoverers in the history of the world, Dalton and Joule. Joule read his first paper before the Manchester Literary and Philosophical Society in the year 1841 upon the subject of "The Electric Origin of the Heat of Combustion." He contributed a long series of papers from that year until 1879, a period of thirty-eight years, and he dealt with a great variety of subjects, including experimental investigations on the phenomena of the voltaic current, the determination of the specific heat of bodies, heat and constitution of elastic fluids, mirage, freezing point of thermometers, galvanometers, dip circle, solar photographs, duty of electro-magnetic engines, magnetic storms, polarisation of platinum plates, mercurial air-pumps, and telescopic oscillations.

The debt of the practical engineer to Joule and his great associates is very real, but the science of thermodynamics did not supply the fundamental laws from which heat-engines were invented and developed. The steam-engine had been developed by Newcomen, Smeaton, and James Watt long before the birth of the science of thermodynamics. What is true of the steam-engine is true also of the hot-air engine and the internal-combustion engine; all the known types of heat-engine at present in use were invented before the year 1850, and practical experimental examples of both hot-air and internal-combustion engines were then in operative existence. Thermodynamics supplied the laws of the conversion of heat into mechanical work by which these engines are governed; it explained the relative perfection of engines already in existence, but it did not create these engines. It performed the very important service of dispelling the errors of thought which hindered the future advance of heat-engines Such errors as to the theory of the regenerator and the theory of compression and expansion in all steam and internal-combustion engines, held by the most eminent engineers and scientific men so late as from 1845 to 1853, were rendered impossible by the splendid work of Joule, Kelvin, Rankine, and their Continental colleagues. The knowledge of thermodynamics has thus an increasing effect upon instructed engineers of the present generation. It is quite obvious that although the origin of heat-engines cannot be ascribed to Joule's work, yet the improvement and final development towards a maximum conversion of heat into mechanical work are rendered possible to the engineer of to-day by his great discoveries. Engineers and engine-designers are most grateful to Joule, and look back on his achievements as those of the utmost intellectual and practical importance.

Giant and Dwarf Stars.[2]

THE amount of light received from a star determines its *apparent magnitude* (m), the ratio for two stars differing by one magnitude being 2·512. The *absolute magnitude* (M) is what the apparent magnitude would be if the star were at the standard distance of 10 parsecs, which corresponds to a parallax of 0·1″. If π is the parallax of a star in seconds of arc,

$$M = m + 5 + 5 \log \pi.$$

In this equation m is not difficult to measure, and hence if π or M is determined the other can be found.

Russell took all stars for which fairly accurate values of π were available, and from the above equation computed M. Then, plotting M as ordinate and type of spectrum as abscissa, he found that (1) all white stars are far brighter than the sun; (2) range of brightness increases with redness; (3) all faint stars are red; and (4) all red stars are very bright or very faint.

Adams and Kohlschütter found that the relative intensity of selected lines in the spectrum of a star depended on the absolute magnitude from measurements on the spectrum. M being determined, the

[1] Abstract of the first Joule Memorial Lecture delivered on Tuesday, December 14, 1920, to the Manchester Literary and Philosophical Society.

[2] Abstract of a lecture delivered before the Royal Society of Victoria, Melbourne, on October 14, 1920, by Dr. J. M. Baldwin, Government Astronomer.

equation gives π, and thus the parallax can be measured spectroscopically. This work brought out very clearly the division of the red stars into a very bright group and a very faint group, with no stars of intermediate brightness.

The absolute magnitude depends on mass, density, and surface brightness. The only information as to mass is obtained from binary stars, and for these the total range in mass is only from nineteen times that of the sun to one-quarter that of the sun.

The surface brightness for stars with similar spectra must be nearly equal, and thus the average red star of the bright group, which gives out 1000 times as much light as the average red star of the faint group, must have 1000 times the surface and 30,000 times the volume of the latter. Hence the terms "giant" and "dwarf." If the masses are equal the densities will be in the ratio 30,000 to 1.

For special classes of stars the relative surface brightness can be obtained, and it is found that the very white stars give out 500 times as much light per unit-surface as the very red stars. For the giant stars the density increases from the red stars to the white, while for the dwarf stars the density increases from the white stars to the red. As the giant stars contract and get hotter the increase in surface brightness nearly balances the decrease in surface, and the stars remain nearly constant in brightness, as is actually found to be the case. After a limiting density is reached cooling follows further contraction, and both the surface brightness and surface decrease together, and a rapid diminution of light is the result. This also is confirmed by observation.

University and Educational Intelligence.

LONDON.—Among the proceedings of the Senate on January 19 are the following:—

Miss Philippa Chicheley Esdaile, D.Sc. (Manchester), has been appointed as from February 1 to the University readership in biology tenable in the Household and Social Science Department of King's College for Women. Miss Esdaile has held a zoological research studentship and an honorary research fellowship in the University of Manchester, where she has also been assistant demonstrator in the Zoological Department. In 1914 Miss Esdaile was elected to a research fellowship at University College, Reading, and from 1915 to 1920 she was acting head of the Department of Zoology at Bedford College during the absence on war service of Dr. Marett Tims. Since last August she has been senior lecturer on zoology at Birkbeck College. She is the author of various publications, especially on salmon-scale research.

The following doctorates were conferred:—*Ph.D. in Philosophy:* Mr. N. K. Datta, an internal student, of University College, for a thesis entitled "The Vedanta: Its Place as a System of Metaphysics." *D.Sc. in Mathematics:* Mr. S. R. U. Saveer, an external student, for a thesis entitled "On the Instability of the Pear-shaped Figure of Equilibrium of a Rotating Mass of Homogeneous Liquid."

A resolution was adopted expressing the gratification with which the Senate had heard of the anonymous donation of 20,000*l*. made to the authorities of the Middlesex Hospital Medical School for the endowment of the University chair of physiology there tenable.

A LECTURE on "Agricultural Botany" will be given by Prof. R. Biffen at King's College, Strand, W.C.2, on Saturday morning, February 5, at 11 o'clock, in connection with the London County Council's lectures for teachers. The chair will be taken by Sir A. Daniel Hall.

THE War Work Council of the Y.M.C.A. in the United States of America has recently made a grant of 1,960,000 dollars for the fund out of which it provides scholarships and other educational assistance for ex-Service men. The grant makes the funds available for this purpose amount to 6,100,000 dollars. Free scholarship awards representing an expenditure of 2,367,895 dollars have been given to 38,582 former Service men, and in all the sum of 5,050,000 dollars has been apportioned to scholarships.

A COURSE of nine public lectures on "Problems of Modern Science," to be given on Wednesdays at 5.15 p.m., began at King's College on January 19 with a lecture by Prof. J. W. Nicholson on Mathematics. The other subjects and lecturers in the course are as follows:—January 26, Astronomy, Prof. J. B. Dale; February 2, Physics, Prof. O. W. Richardson; February 9, Chemistry, Prof. S. Smiles; February 16, Geology, Prof. W. T. Gordon; February 23, Biology, Prof. A. Dendy; March 2, Botany, Dr. R. Ruggles Gates; March 9, Physiology, Prof. W. D. Halliburton; and March 16, Anatomy, Prof. E. Barclay-Smith. The lectures are free, and cards of admission can be obtained from the Lecture Secretary, King's College, Strand, W.C.2. A stamped addressed envelope should be enclosed.

WITH commendable promptness the Association of Science Teachers has published a new edition of the "Book List" which was issued about a year ago. Sections on zoology, natural history, and astronomy have been added in the present volume, in which the old list has been extended and revised in many ways. The compilation should be of great assistance to those who are responsible for the selection of science books for use in class, for reference by both pupils and teachers, or for general school libraries. Its special value lies in the fact that the books included are in every case recommended by teachers who are exceptionally well qualified to judge of their suitability. "Book List, 1920," may be obtained at the price of 2s. from the Hon. Secretary, Association of Science Teachers, 10 Gresley Road, London, N.19.

FIGURES compiled by the U.S. Bureau of Education showing the public expenditure on education and the incomes of the various colleges, etc., in the United States are issued in *School Life* for December 1 last. The figures for 1918 and previous years are taken from the annual report of the Commissioner of Education; those for 1919 and 1920 are estimated. Throughout the period investigated, from 1870 onwards, the yearly increase in expenditure on education has grown successively larger. In 1870 the charge for elementary schools was 2 dollars per head of the population; it is now 9.50 dollars per head. The income of colleges, universities, and technical schools for 1920 was two and one-third times as much as it was in 1910 and thirty-six times what it was in 1870. The total sum which it is estimated was spent on education in the United States during 1920 is 1,224,000,000 dollars; this sum is approximately half the world's expenditure for educational purposes, although the people served represent only one-seventeenth of the world's population.

PART I. of the Indian Bureau of Education Publication entitled "Selections from Educational Records" has been received. It consists of reprints of a number of documents relating to education in India for the period 1781–1839, which illustrate the gradual growth of the feeling of responsibility for Indian education in the minds of Englishmen. The records which have been utilised come mainly from the Government of India, though a few have been obtained from the record offices of the larger States. They therefore give a general survey of the whole topic rather than detailed descriptions of conditions at any one place. The arrangement is chiefly chronological, but in places documents dealing with the same subject have been brought together irrespective of their real sequence. Brief narratives have been inserted between some of the records in order that the reader may have the less difficulty in following the train of events which led to the production of the various documents.

THE Department of Industrial Administration at the College of Technology, Manchester, has now been running for more than two years, and, judged by the prospectus of classes for the 1920–21 session, it has successfully organised a very elaborate and complete scheme of teaching. It offers a full-time course in industrial administration, which includes a series of forty-two lectures by the director, Prof. Stanley Kent, and others, a short course of laboratory work in industrial fatigue, and visits to works in the neighbourhood. Still more elaborate is the six months' course of training in welfare work, which is designed to supplement the University course on social study. The part-time student is offered two evening courses, each of twenty-six lectures, whilst shorter courses of a more technical nature are offered in engineering and in the cotton industry. Also Prof. T. H. Pear is giving a course of lectures in industrial psychology. In order to ensure that the Department should be kept in close touch with practice, a number of experts have been invited from time to time to deliver public lectures. Some of these lectures have been reprinted and issued in volume form, and they were very favourably reviewed in the columns of NATURE a few months ago. Again, the department is undertaking advanced research work on a diversity of subjects, which include psychological problems of industry, the working conditions in various industries, and technical questions dealing with machine- and hand-cutting tools.

THE annual report of the Royal Technical College, Glasgow, for the year 1919–20 contains not only an account of its activities during the past year, but also a brief summary of events and conditions at the institution during the war period. The most important of the latter was the recognition of the college as a school of university standing by the Treasury University Grants Committee: a preliminary recurrent grant of 3000*l*. and two non-recurrent grants of 6000*l*. and 4000*l*. respectively to meet special expenditure arising out of the war were made. The balance-sheet of the college still shows a deficit, however—the income is 54,084*l*. and the expenditure 57,490*l*.—in spite of the fact that students' fees already bring in 30 per cent. of the total income and annual grants of 1000*l*. each have been received from the Bellahouston Trustees and the Carnegie University Trust. The number of students attending courses during 1919–20 rose to 5690, of which 1135 were day and 4555 evening pupils—figures which exceed those for 1913–14 by 466 and 213 respectively. To meet this influx while the staff was much under strength the first-year courses were triplicated. A summary giving the number of enrolments in each department of the college shows that for full-time students chemistry is the great attraction, while of the evening students the majority attend courses in mechanics. The latter are designed to provide for the higher studies which can be developed from the series of affiliated evening classes conducted by the neighbouring county education authorities in conjunction with the college. A Ferguson research fellowship in chemistry of the value of 200*l*. per annum has been founded by the trustees of the Ferguson Bequest Fund.

Calendar of Scientific Pioneers.

January 27, 1823. Charles Hutton died.—A labourer's son and largely self-taught, Hutton became professor of mathematics at the Royal Military Academy, Woolwich. From Maskelyne's experiments he calculated for the first time the mean density of the earth.

January 27, 1851. John James Audubon died.—Of French descent, Audubon was born at New Orleans, and devoted his life to the study of the birds of North America.

January 27, 1873. Adam Sedgwick died.—The contemporary of Murchison and Lyell, Sedgwick was "one of the greatest leaders in the heroic age of geology."

January 28, 1687. Johann Hevel or Hevelius died.—Seven years before the end of the disastrous Thirty Years' War, which nearly extinguished the study of science in Germany, Hevelius built an observatory and set up a printing press at Danzig, and by his subsequent labours earned for himself the reputation of "the greatest observer after Tycho Brahe."

January 29, 1859. William Cranch Bond died.—The first director of Harvard Observatory, Bond in 1848, simultaneously with Lassell, discovered Hyperion, one of the satellites of Saturn; and on November 15, 1850, observed the "Crape" ring, a dusky ring within the inner portion of Saturn's bright ring.

January 30, 1888. Asa Gray died.—Born in 1810, Gray for many years occupied the chair of natural history at Harvard and wrote numerous works on the flora of North America.

February 1, 1873. Matthew Fontaine Maury died.—A naval officer and first director of the Naval Observatory at Washington, Maury became the foremost hydrographer of his day.

February 1, 1903. Sir George Gabriel Stokes died.—Lucasian professor at Cambridge for fifty-four years, secretary and president of the Royal Society, Member of Parliament, and foreign associate of the Institute of France, the influence of Stokes in the world of science was scarcely less than that of Kelvin. His own investigations referred mainly to the motion of fluids and to optics. He was a pioneer in the discovery and development of spectrum analysis, discussed the nature of fluorescence, and is regarded as the virtual founder of the modern science of geodesy.

February 2, 1704. Guillaume Antoine de l'Hospital, Marquis de St. Mesme, died.—His "Analyse des Infiniments Petits" (1696) was the first treatise on the infinitesimal calculus.

February 2, 1907. Dmitri Ivanovitsch Mendeléeff died.—Mendeléeff was born in 1834 at Tobolsk, in Siberia, and from an exile he gained his first knowledge of science. In 1850, his father being dead, the family removed to Petersburg, where at the age of thirty-two, having established a reputation as an investigator, he was made professor of general chemistry in the University. Three years later, in March, 1869, before the Russian Chemical Society, he enunciated the "periodic law." Foreshadowed by Newlands and others and confirmed by Lothar Meyer, this great generalisation, connecting the properties of the elements with their atomic weights, made his name widely known, and by it he was able to predict the existence of elements hitherto unknown but afterwards discovered.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, January 20.—Prof. C. S. Sherrington, president, in the chair.—Sir Robert **Hadfield**, S. R. **Williams**, and I. S. **Bowen**: The magnetic mechanical analysis of manganese steel. Tests were made on six rods quenched in water, when they are in the non-magnetic condition, and three were afterwards annealed, which rendered them magnetic. The changes in length of the rods when subjected to magnetic fields were determined (Joule effect). In the case of the rods in the magnetic condition the change was an increment for all field strengths. No change in length could be detected for the non-magnetic specimens. The effect on the intensity of magnetisation when subjected to longitudinal stress (Villari effect) was investigated. An absolute method of measuring the intensity of magnetisation when comparatively small was adopted, and for all field strengths the application of tensile stress increased the intensity of magnetisation of the magnetic specimens. The non-magnetic rods showed no change in intensity of magnetisation by being stretched. They showed an intensity of magnetisation about 1/36th of that of the specimens in the magnetic condition, due entirely to oxidation of the skin of the rods.—Dr. W. S. **Tucker** and E. T. **Paris**: A selective hot-wire microphone. The instrument consists of an electrically heated grid of fine platinum wire placed in the neck of a Helmholtz resonator. The effect of a sound having the same frequency as that natural to the resonator itself is to produce an oscillatory motion of the air in the neck of the resonator, which in turn causes changes in resistance of the platinum-wire grid. The total resistance change comprises a steady fall in resistance due to an average cooling of the grid, and a periodic change due to the to-and-fro motion of the air. Two methods of using the microphone are described: (1) A bridge method, and (2) an amplifier method. Curves are given showing the sharpness of resonance as measured by the bridge method. Results of experiments on cooling the grid by low-velocity air-currents are described. The principal resistance changes to be expected when the grid is cooled by an oscillatory air-current are: (1) A steady drop due to an average cooling; (2) a periodic resistance change of the same frequency as that of the sound; and (3) a periodic resistance change of frequency twice that of the sound. Further deductions are that the steady change of resistance is proportional to the *intensity* of the sound, while the periodic resistance change in (2) is proportional to the *amplitude*.—E. A. **Milne** and R. H. **Fowler**: Siren harmonics and a pure-tone siren. The ordinary siren can be regarded as a point source of air of variable flux, the flux being proportional to the area of the orifice exposed by the holes in the disc. The relative intensities of the harmonics for a siren with circular holes and a circular orifice are calculated, and it is concluded that a fairly pure note should be obtained from a siren of this type, in which the distance between the centres of adjacent holes is twice the diameter of the holes. If the original is rectangular in section, the holes can be so shaped that the area of the orifice exposed varies exactly as the sine of the displacement.—L. V. **King**: The design of diaphragms capable of continuous tuning. Continuous tuning is achieved by the application of air-pressure (or suction). The diaphragm is constructed from a single piece of metal, and consists of a thick, undeformable, central disc connected by a thin, concentric, annular portion to a heavy, circular rim fitted accurately on a rigid mounting. The application of air-pressure over the interior of the diaphragm alters the tension of the thin annular portion, so that the rigid central portion vibrates about the static equilibrium position with a different pitch. To realise sharp tuning and high sensitivity, diaphragms of this type should be made with almost optical precision in the form of accurate solids of revolution.

Royal Meteorological Society, January 19.—Mr. R. H. Hooker, president, in the chair.—Mr. R. H. **Hooker**: Presidential address: Forecasting the crops from the weather. Mr. Hooker remarked that forecasts of the harvest fell into two main groups, viz. those which predicted the recurrence of good and bad crops in cycles, and those which computed the actual amount by which the yield was improved or damaged by the weather during or shortly before the growing period. He outlined the evolution of the methods of ascertaining relationships between the weather at different seasons of the year and the subsequent harvest. Originally writers such as Gilbert and Lawes could only examine the meteorological conditions in years of exceptional abundance or scarcity. A great advance was made when Sir Rawson Rawson and, later, Sir Napier Shaw, from the study of an entire sequence of crops and previous weather conditions, suggested formulæ from which the crop might be calculated, while still wider possibilities were opened by the methods of correlation. Mr. Hooker emphasised the necessity of taking the past weather into account in predicting the harvest, as it was abundantly clear, from comparison with actual forecasts in India and elsewhere, that the weather was responsible for developments in the plant which were not visible to an observer surveying the young crops in the fields; and, although much work still remained to be done, the time was ripe for using such statistics to confirm or modify the results of direct observation of the growing plants.

ROME.

Reale Accademia nazionale dei Lincei, November 7.—Signor V. Volterra, vice-president, in the chair.—S. **Pincherle**: Certain functional equations.—O. M. **Corbino**: Electronic theory of electric conductivity in magnetic field.—F. **Millosevich**: Paternoite, a new mineral from Calascibetta, Sicily. This is a borate of magnesia containing chlorine, similar in appearance to stassfurtite, and found in the saline deposits of Monte Sambuco.—B. **Longo**: The "flowerless apple" (*Pyrus apetala*, Mönch). This plant only produces small aborted pistilliferous flowers, and does not present any trace of stamens. These flowers possess carpels disposed in two planes, some of which contain more or less imperfect ovules. By fertilising with the pollen of other kinds of apples the author has obtained actual seeds, which it is proposed to try growing.—A. **Denjoy**: "Sur une classe d'ensembles parfaits discontinus."—O. **Onicescu**: Spaces admitting infinitesimal translation along lines of zero length.—A. **Clementi**: A new hypothesis regarding the physiological significance of protamines and histones in nuclear exchanges.—The president, Signor Volterra, directed attention to the cost of printing scientific publications, and urged the necessity of State aid for this purpose. The losses by death sustained by the Academy during the last session include Senators Righi and Celoria and Profs. Cuboni, Beccari, Rajna, and Giglioli.

MELBOURNE.

Royal Society of Victoria, October 14.—Prof. A. J. Ewart, president, in the chair.—D. K. **Picken**: A generalisation of elementary geometry. The subject of this paper was an outstanding defect of generality in elementary geometry associated with the ambiguity (equal or supplementary) in certain fundamental angle theorems. The appropriate principle of generality was first arrived at by the author in a paper on Simson's line read to the Edinburgh Mathematical Society in May, 1914. Later consideration had made it clear that the principles in question are basic to the elementary geometry of the straight line, of parallels, and of the circle, and are of wide applicability in the geometrical theory dependent upon these. —Dr. J. M. **Baldwin**: Giant and dwarf stars (see p. 711).

SYDNEY.

Linnean Society of New South Wales, November 24.—Mr. J. J. Fletcher, president, in the chair.—G. H. **Hardy**: Revision of the Chiromyzini (Diptera). A study of the genus Metoponia and its allies, following on Miss Irwin-Smith's study of the larva of *M. rubriceps*, Macquart.—J. **Mitchell**: Some new Brachiopods from the Middle Palæozoic rocks of New South Wales. From rocks of Upper Silurian age at Bowning, Hatton's Corner, and near Molong, one genus and four species are described as new.—Vera **Irwin-Smith**: Nematode parasites of the domestic pigeon (*Columba livia domestica*) in Australia. The only Nematode hitherto recorded from this host in Australia is *Ascaridea columbae*, Gmelin, from both New South Wales and Queensland. Records of two further species are added, and a new generic name is proposed for *Strongylus quadriradiatus*, Stevenson.—J. H. **Maiden**: A few notes on the botany of Lord Howe Island (sixth paper). This brief paper supplements existing information in regard to hybrid Howeas, which have been under cultivation in the Sydney Botanic Gardens for a number of years. There are notes on indigenous plants hitherto unrecorded, of which *Adiantum formosum*, R. Br., is the most important. A number of records of introduced plants are also given.

Books Received.

The Child's Path to Freedom. By N. MacMunn. Second edition. Pp. 163. (London: G. Bell and Sons, Ltd.) 2s. 6d. net.

A Concise Geometry. By C. V. Durell. (Cambridge Mathematical Series.) Pp. viii+319. (London: G. Bell and Sons, Ltd.) 5s. net.

My Electrical Workshop. By F. F. Addyman. Pp. viii+249. (London: Wireless Press, Ltd.) 7s. net.

A Text-book of Practical Chemistry. By G. F. Hood and Major J. A. Carpenter. Pp. xii+527. (London: J. and A. Churchill.) 21s. net.

The Fundamental Processes of Dye Chemistry. By Prof. H. E. Fierz-David. Translated by Dr. F. A. Mason. Pp. xiv+240+xiv plates. (London: J. and A. Churchill.) 21s. net.

Volumetric Analysis for Students of Pharmaceutical and General Chemistry. By C. H. Hampshire. Third edition. Pp. iv+124. (London: J. and A. Churchill.) 7s. 6d. net.

Farm Crops Laboratory Manual and Note Book. By F. W. Lathrop. Pp. 118. (Philadelphia and London: J. B. Lippincott Co.) 4s. 6d. net.

Oil Firing for Kitchen Ranges and Steam Boilers. By E. C. Bowden-Smith. Pp. ix+102. (London: Constable and Co., Ltd.) 9s. net.

The Science of Ourselves. (A Sequel to "The Descent of Man.") By Sir B. Fuller. (Oxford Medical Publications.) Pp. ix+326. (London: Henry Frowde and Hodder and Stoughton.) 16s. net.

Die Anaphylaxie. By Prof. Ch. Richet. Autorisierte Uebersetzung von Dr. J. Negrin y López. Pp. iv+221. (Leipzig: Akademische Verlagsgesellschaft.)

Association of Science Teachers. Book List. Second edition, 1920. Pp. 47. (London: Association of Science Teachers.) 2s.

The Absolute Relations of Time and Space. By Dr. A. A. Robb. Pp. ix+80. (Cambridge: At the University Press.) 5s. net.

Modern High-speed Influence Machines. By V. E. Johnson. Pp. viii+278. (London: E. and F. N. Spon, Ltd.) 14s. net.

The Repairing Optician: A Beginner's Guide to the Optical Workshop. By J. Fray. (Oxford Technical Manuals.) Pp. viii+183. (London: Henry Frowde and Hodder and Stoughton.) 8s. 6d. net.

Handbook of Metallurgy. By Prof. C. Schnabel. Translated by Prof. H. Louis. Third edition. Vol. i.: Copper–Lead–Silver–Gold. Pp. xxi+1171. (London: Macmillan and Co., Ltd.) 40s. net.

Co-ordinate Geometry (Plane and Solid) for Beginners. By R. C. Fawdry. Pp. viii+215. (London: G. Bell and Sons, Ltd.) 5s.

The Theory of Functions of a Real Variable and the Theory of Fourier's Series. By Prof. E. W. Hobson. Second edition. Vol. i. Pp. xvi+671. (Cambridge: At the University Press.) 45s. net.

Exploitation du Pétrole par Puits et Galeries. By Paul de Chambrier. Pp 106. (Paris: Librairie Dunod.)

Cotton Spinning. By W. S. Taggart. Vol. i. Seventh edition. Pp. liii+362. (London: Macmillan and Co., Ltd.) 8s. 6d. net.

College Botany: Structure, Physiology, and Economics of Plants. By Dr. M. T. Cook. Pp. x+392. (Philadelphia and London: J. B. Lippincott Co.) 12s. 6d. net.

Standard Method of Testing Juvenile Mentality by the Binet-Simon Scale and the Porteus Scale of Performance Tests. By N. J. Melville. Second edition. Pp. xi+162. (Philadelphia and London: J. B. Lippincott Co.) 12s. 6d. net.

Soil Alkali: Its Origin, Nature, and Treatment. By Prof. F. S. Harris. Pp. xvi+258. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 13s. 6d. net.

West African Congress and Government on Native Lines. By R. E. Dennett. Pp. 31. (London: The *African World*.)

Memoirs and Proceedings of the Manchester Literary and Philosophical Society, 1918–19. Vol. lxiii. (Manchester.) 12s.

Annuario publicado pelo Observatorio Nacional do Rio de Janeiro. Para o Anno de 1921. Anno XXXVII. Pp. xviii+443. (Rio de Janeiro.)

The Journal of the Institute of Metals. Vol. xxiv., No. 2. 1920. Edited by G. Shaw Scott. Pp. xiv+527+xl plates. (London: Institute of Metals.) 31s. 6d. net.

Annals of the Solar Physics Observatory, Cambridge. Vol. iv., part 1. The Spectrum of Nova Geminorum II. By F. J. M. Stratton, under the direction of H. F. Newall. Pp. viii+71+2 plates. (Cambridge: At the University Press.)

Bibliotheca Chemico-Mathematica. Catalogue of Works in Many Tongues on Exact and Applied Science, with a Subject Index. Compiled and annotated by H. Z. and H. C. S. Vol. i. Pp. xii+428+plates. Vol. ii. Pp. 429–964+plates. (London: H. Sotheran and Co.) 3l. 3s. net.

Schriften der Naturforschenden Gesellschaft in Danzig. Neue Folge. Fünfzehnten Bandes Erstes und Zweites Heft. III. Teil., Wissenschaftliche Abhandlungen. Pp. iii+190. (Danzig.)

Great Britain in the Latest Age: From Laisser Faire to State Control. By A. S. Turberville and

F. A. Howe. Pp. vii+342. (London: J. Murray.) 7s. 6d. net.

Wireless Telegraphy and Telephony: An Outline for Electrical Engineers and Others. By L. B. Turner. Pp. xii+195+xxiv plates. (Cambridge: At the University Press.) 20s. net.

Devonian Floras: A Study of the Origin of Cormophyta. By Dr. E. A. Newall Arber. Pp. xiv+100. (Cambridge: At the University Press.) 17s. 6d. net.

Domestic Fuel Consumption. By A. H. Barker. (The Chadwick Library.) Pp. x+159. (London: Constable and Co., Ltd.) 14s. net.

A Text-book of Inorganic Chemistry for University Students. By Prof. J. R. Partington. Pp. xii+1062. (London: Macmillan and Co., Ltd.) 25s. net.

Meteorological Office. British Meteorological and Magnetic Year Book, 1917. Part iv.: Hourly Values from Autographic Records, 1917. Pp. 91+iii plates. (M.O. 229f.) (London: Meteorological Office, Air Ministry.) 12s. 6d. net.

Diary of Societies.

THURSDAY, JANUARY 27.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. A. Harden: Biochemistry (Vitamines).

ROYAL SOCIETY, at 4.30.—K. Sassa and Prof. C. S. Sherrington: The Myogram of the Flexor-reflex evolved by a Single Break-shock.—Sir Almroth Wright: "Interaction" between Albuminous Substances and Saline Solutions.—Dr. S. Russ, Dr. Helen Chambers, and Gladwys M. Scott: The Local and Generalised Action of Radium and X-rays upon Tumour Growth.

NEWCOMEN SOCIETY (at Iron and Steel Institute), at 5.—R. Jenkins: Rise and Fall of the Iron Manufacture in Sussex.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.30.—Dr. G. L. Pardington: Advancing Years and Balneotherapy (Presidential Address).

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—G. A. Juhlin: Temperature Limits of Large Alternators.

LONDON DERMATOLOGICAL SOCIETY, at 6.—Dr. W. K. Sibley: Acne (Chesterfield Lecture).

CONCRETE INSTITUTE, at 7.30.—J. A. Howe: Geology in Relation to Building Stones.

WIRELESS SOCIETY OF LONDON (at Royal Society of Arts), at 8.

SOCIETY OF ANTIQUARIES, at 8.30.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—T. Walker: Obstruction After Suprapubic Prostatectomy and an Open Operation for its Prevention.

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ASSOCIATION OF ECONOMIC BIOLOGISTS (at Imperial College of Science), at 2.30.—Dr. L. Lloyd: Greenhouse White Fly and its Control.—W. B. Brierley: Personal Impressions of Some American Biologists and their Problems.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children), at 5.—Dr. P. Parkinson: A Case of Patent Ductus Arteriosus.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Keith: The Principles of Craniology applied to Clinical and Racial Problems.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—Prof. H. Nagaoka: The Magnetic Separation of the Neon Lines and Runge's Rule.—Capt. E. V. Appleton: A Method of Demonstrating the Retro-active Property of a Triode Oscillator.—Dr. D. Owen and R. M. Archer: The Quickness of Response of Current to Voltage in a Thermionic Tube.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—J. W. Wardell: Manufacture of Portland Cement.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.30.—Dr. A. S. M. MacGregor: Some Features of Current Small-pox in Glasgow.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir James Dewar: Cloudland Studies.

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ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—J. W. Simpson: Presidential Address to Students and Distribution of Prizes.

ROYAL SOCIETY OF ARTS, at 8.—A. E. L. Chorlton: Aero Engines (Howard Lectures).

MEDICAL SOCIETY OF LONDON, at 8.30.—Dr. A. Feiling: Multiple Neuritis.—Dr. F. G. Crookshank: Handprints in Mongolian and Other Imbeciles.

TUESDAY, FEBRUARY 1.

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INSTITUTION OF CIVIL ENGINEERS, at 5.30.—Brevet-Major G. le Q. Martel: Bridging in the Field.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—P. King: The Cinematograph Camera: Various Models and General Description of Same.

WEDNESDAY, FEBRUARY 2.

ROYAL SOCIETY OF ARTS, at 8.—A. F. Baillie: Oil-burning Methods in Various Parts of the World.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. W. G. Howarth: Mucocele and Pyocele of the Nasal Accessory Sinuses.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (Annual General Meeting) (at Chemical Society), at 8.—Presidential Address.—F. W. Smith: Extract of Red Squill (*Scilla maritima*) as a Rat Poison.—W. Lowson: The Composition of Harrogate Mineral Waters.

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ROYAL SOCIETY, at 4.30.—*Probable Papers*.—Dr. G. B. Jeffery: The Field of an Electron on Einstein's Theory of Gravitation.—Dr. M. N. Saha: A Physical Theory of Stellar Spectra.—W. F. Darke, J. W. McBain, and C. S. Salmon: The Ultra-microscopic Structure of Soaps.—Dr. J. Mercer: Linear Transformations and Functions of Positive Type.

LINNEAN SOCIETY, at 5.—Miller Christy: Wistman's Wood, Dartmoor; Specimens of Slides.—Dr. Agnes Arber: Leaf-tips of Monocotyledons.—T. A. Dymes: Seedlings of *Ruscus aculeatus*, with Remarks on their Germination and Growth.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Major G. Dobson: The Use of Meteorology to Aviation and *Vice-versa*.—Wing-Comdr. H. W. S. Outram: Ground Engineering.

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ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—On Gravity at Sea: Opened by Prof. G. W. Duffield, and continued by Sir S. G. Burrard, Dr. H. Jeffreys, Dr. J. W. Evans, and Dr. A. M. Davies. Chairman: Sir Arthur Schuster.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. C. W. G. Bryan: The Early and Late Effects of Injuries of the Diaphragm, with Social Reference to Wounds jointly involving Thoracic and Abdominal Viscera.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. A. D. Waller: The Electrical Expression of Human Emotion.

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NATURE

THURSDAY, FEBRUARY 3, 1921.

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Anthropology and Empire.

ANTHROPOLOGY has been slow to secure recognition as having a practical bearing on the affairs of life. The Royal Anthropological Institute, which has just completed the fiftieth year of its existence, while steadily pursuing its main object of promoting the study of man, has constantly insisted upon the importance of this science as a fundamental element in certain departments of legislation and administration, particularly in relation to the native peoples of our Colonies and Dependencies. Until comparatively recently it has obtained a sympathetic hearing more often than a tangible result.

It is unnecessary to enumerate here the many occasions on which this subject has been brought to the notice of the Government at home and of the authorities in our Dependencies. The latest attempt to secure official recognition of the place of anthropological studies in the training of administrative officials was initiated by Sir Richard Temple at the Birmingham meeting of the British Association in 1913. He advocated the establishment of an Imperial School of Anthropology attached to one of the universities. Unfortunately, the outbreak of war interrupted a movement which had secured wide and influential support.

It is important to note that the conception of the vital importance of "applied anthropology" as an essential part of the training of an administrator is not academic in origin. Its strongest advocates are, or have been, men like Sir Herbert Risley, Sir Bampfylde Fuller, Sir Richard Temple, Sir Everard im Thurn, and Sir Reginald Wingate, to name a few only, who have themselves had a prolonged administrative experience, and have found a knowledge of native manners and customs essential to the successful performance of their duties. Sir Reginald Wingate, in particular, as Governor-General of the Sudan, asked the Universities of Oxford and Cambridge to provide instruction in anthropology to probationers for the Sudan Service, and it was at his special request that Prof. and Mrs. Seligman were sent to the Sudan to collect information which might be available for this purpose.

It is a matter of common experience that sympathy based upon knowledge is a first essential for both administrator and trader. Habits, customs, beliefs, and, particularly, etiquette must be intimately known and thoroughly understood. Ignorance of etiquette has been responsible for more than one punitive expedition, costly in both life and money. During the war, when comparatively large numbers of British officers had to be drafted to Indian battalions, it was found essential that they should receive instruction, not merely in the language, but also in the social grades, customs, and beliefs of their troops. Knowledge of native manners, customs, and beliefs has proved a bond of sympathy between governors and governed. Successful administrators have acquired this knowledge painfully and as a result of many mistakes. As one observer of considerable experience has said, the knowledge which had taken years to gain could have been acquired by a trained anthropologist in a few weeks.

If sympathetic knowledge is a factor of such importance in the relations between individuals, it is a paramount consideration in determining the character of administrative regulations and legislative measures which deal with the native in the mass. Success in maintaining law and order depends, in the long run, on the avoidance of any infringement of the customary rights of individuals and social units, as well as of any offence to the modes of thought and beliefs of the subject population. Further, when European culture comes intimately and extensively into touch with a lower culture, it is inevitable that many customs and beliefs of the less highly advanced must seem repugnant and even intolerable when judged by the standard of the more civilised race. Cannibalism and the practice of *sati* in India are cases in point. It is a matter of experience, however, that any modification or restriction of custom should be attempted only after very careful consideration of its place in the life of the people and of the possible consequence of any change. The suppression of the *lobola*, or "bride-price," in South Africa, under the mistaken impression that it was a sale, led to a great deal of ill-feeling and injustice; during the period in which it was interdicted, no marriage was regarded by the natives as legal, and, more important, one of the main factors in their social organisation had disappeared. A little knowledge of anthropology and anthropological method would have averted action which led to much distrust of British rule.

At the present moment the government of our subject races is beset with difficulties. How deep-rooted these difficulties are possibly only anthropologists and administrators in intimate touch with native feeling are fully aware. Native races tend to die out after contact with a civilisation which brings European diseases and European vices in its train; but this is not invariably the case. In some areas the removal of the checks on over-population, such as female infanticide and inter-tribal warfare, has brought about an increase, as in South Africa. In the case of the dying races the excellent system of segregation in reservations, even with an assured food supply and medical attention, appears merely to delay the inevitable. The possibility of preserving these peoples offers a vast field for anthropological research. The problem is not merely humanitarian. The exploitation of the tropics, which is inevitable as the world's needs increase under the pressure of population, depends on labour which will have to be drawn from native races, as, owing to climatic and other causes, white labour will not be available. This, however, is no argument in favour of compulsory or indentured labour. Primitive peoples, though often called lazy, do not differ materially from civilised peoples in their attitude towards labour; they work according to their needs and desires. The labour problem can be solved only by a careful study of primitive economics and industry. Such study should serve as a basis for a system of education and development which will foster native arts and handicrafts. The gradual improvement of native methods of agriculture will have an important bearing on the food supply of the future. But here, again, there is need for knowledge and sympathy before any change is introduced, as native methods are hedged round by custom and belief.

In cases where the native population is numerous and on the increase, the social and political question has been forced into prominence. During and after the war political agitators penetrated to the remotest parts of the Empire. The cases of India and South Africa are singular only in being widely known. Can anthropology assist the State in solving the difficult problem of converting what is now a danger into a useful section of the community? The far-sighted proposals introduced into the Parliament of the Union of South Africa last year by General Smuts suggest an answer. Study of native institutions will indicate such as may be utilised to develop the political sense of the native through local self-government, and at the same time suggest lines of development along which he may be led until he reaches a stage at which he will be fitted to take such a part in the political organism as time and experience may suggest to be desirable in the interests of himself and of the community at large.

The greater amount of attention which has been paid to primitive races has tended to obscure the fact that the study of the peoples of these islands has a bearing on practical affairs of an equal, if not greater, importance. Sir Francis Galton, when president of the Anthropological Institute in the late eighties of last century, insisted upon the importance of the study of our own population. He himself had then for many years been collecting data bearing upon the distribution of intelligence among the different classes of the population and upon the problems of heredity. The report of the Inter-Departmental Committee on Physical Deterioration, published in 1904, furnished evidence of the utterly inadequate extent of our knowledge of the physical characters of the population of these islands. Medical inspection of schools, which includes certain physical measurements, and is now extended permissively to observations of a specifically anthropological character, as well as the institution of a Ministry of Health, has done something to remedy this defect in certain directions. Anthropologists, however, are well aware how far the results have been, or are likely to be, vitiated by an imperfect knowledge of the distribution of racial characters. The institution of an anthropological survey presents many difficulties not entirely confined to expense. There can, however, be little doubt as to its practical value, not only in connection with the health and physique of the population, but also because of its bearing upon the study of mental character, the influence of heredity and environment, the relation of race and disease, the incidence of insanity and crime, and a number of other questions intimately bound up with and affecting the character of future social legislation.

The Determination of Sex.

Mechanismus und Physiologie der Geschlechtsbestimmung. By Prof. Richard Goldschmidt. Pp. viii+251. (Berlin: Gebrüder Borntraeger, 1920.) Price 32 marks.

THOUGH Prof. Goldschmidt's treatise on sex-determination is in scope similar to the text-books published by Doncaster and by Morgan in 1912, knowledge has increased so rapidly since then that there is plenty of room for a new statement. Moreover, as the author has himself devoted several years to the study of a special case which departs from the ordinary rules, his views will be of interest to geneticists. Up to a point, the mechanism of sex-determination is clear. On the one hand, we know that in several birds and some Lepidoptera the female is heterozygous in sex, but we have equally sound proof that in man and in several insects other than Lepidoptera the condition is reversed, the female being homozygous and the male heterozygous in respect of the sex-factor. The evidence for these conclusions is mainly either genetical or cytological. With the exception of Drosophila, which, after some doubt, observers have agreed to regard as having the male XY and the female XX, there is no specific form in which positive evidence of both kinds, genetical as well as cytological, can yet be produced. The absence, however, of such convergent testimony need not trouble us at this stage, for each class of proof is by itself adequate so far as it goes. On the whole, also, though difficulties are met with in special examples, the evidence from operative and other collateral observations agrees well with the conclusions deduced from genetical and cytological sources.

Sex being, then, decided by the contribution which one or other of the gametes makes to the offspring, how shall we account for cases in which these seemingly predetermined consequences can by interferences of various kinds be disturbed? Evidence of this description falls into several classes, and its consideration forms a chief purpose of the present book. Hitherto the most famous is that provided by R. Hertwig's experiments on frogs. By delaying fertilisation, he found that the proportion of males could be greatly increased. The suggestion that the females had died off was shown to be inapplicable, and there seemed to be no escape from the conclusion that eggs which in the ordinary course would have become females did after, and presumably because of the delay in fertilisation, become males. The fact, however, that the maturation-divisions in the case of the frog occur after the eggs are laid offered, as Hertwig pointed out, a possible, if rather unlikely, solution; for the artificial delay might have some influence in deciding which elements should be extruded in the polar bodies, and thus the sex-ratio might be disturbed. Quite recently Seiler, a colleague of Prof. Goldschmidt's, claims to have actually witnessed consequences of this kind following upon the introduction of special conditions in the case of the Psychid moth Talæporia, and to have obtained cytological evidence that a rise of temperature during the reduction-division caused the X-chromosome to stay more often inside the egg, and so increased the proportion of males, whereas a lowering of the temperature had the contrary effect. In the case of the frog, even if the delay does act in the way surmised, various difficulties remain to be elucidated, and before definite conclusions can be reached as to sex-determination in Amphibia, and fishes also, we require strict genetical proof as to which sex in those animals is heterozygous in the sex-factor.

Much more serious difficulty arises from a class of fact to which Standfuss was, I believe, the first to introduce us. He found that in Lepidoptera hybridisation might affect the sexes differentially, producing in certain crosses males only, in others predominantly males (the few females being sterile), and similar phenomena proving that the influence of the cross was not alike for the two sexes. A result obtained by an amateur named Brake led Prof. Goldschmidt to investigate a most remarkable case of such differential influence. *Lymantria dispar,* the gipsy moth, is represented by various races all over the northern temperate regions. The sexes are very different, the male being small and dark, the female large and pale in colour. The original observation was that, whereas crosses in the form Japanese ♀ × European ♂ gave in F_1 the two sexes distributed as usual, the reciprocal cross, European ♀ × Japanese ♂, produced normal males, but *females more or less modified in the male direction.* Eggs, therefore, which, if fertilised by the sperm of European males, would have produced females gave rise to "intersexual females," as Prof. Goldschmidt calls them, when the sperm came from these Japanese males. To investigate this curious problem, he proceeded to Japan before the outbreak of the war, and when Japan became involved he went to the United States, where he was interned and encountered other serious difficulties when that nation also joined the Allies. But in the course of his travels he was able to collect and experiment with a long series of species or local races inhabiting various parts of Europe, Japan, and North America, raising something like 50,000 specimens. Obscure as the meaning of the phenomena still is, there can be no question that when the full interpretation is unravelled the work will be admitted to have an importance at least proportionate to the astonishing labour which has gone to its production.

In outline the main result claimed is that the various races can be arranged in a scale ranging from the "strongest" to the "weakest," and, this series once established, the consequences of matings made between races occupying different positions on the scale can be predicted with considerable accuracy. Intersexual females appeared whenever the male of a "stronger" race was mated with the female of a "weaker." The intersexuality in its several degrees might affect all the sexual characters, primary or secondary, and in its higher manifestations the instincts also. Where such a diversity of features is concerned, a quantitative scale must obviously be largely a matter of individual judgment, but it is claimed that the amount to which these females were modified in the male direction was roughly proportional to the interval between the parent races on the scale of strength; and in the extreme case, when the strongest male was mated with the weakest female, the brood generally consisted of males only, which are interpreted as being in part aboriginal, genetically determined males, and in part individuals which would have been females but for the disturbing influence which has transformed them into males.

Other matings led to the production of intersexual *males*. The discrimination between the two kinds of intersexes was not, to judge from the illustrations, so difficult as one would have expected. The intersexual males appeared with some regularity in F_2 from the cross mentioned above (Japanese ♀ × European ♂) as giving all normals in F_1 and in certain other families besides. There were also some considerable families all-female. Throughout the complicated series of matings glimpses of order appear which suggest that a comprehensive solution is not very far off. It has, nevertheless, not yet been attained. One of the most curious features, as yet inexplicable, is the fact that in the matings giving all-male families females occasionally appear which are perfectly normal, though their sisters are supposed to have been wholly transformed into males.

The interpretation which Prof. Goldschmidt proposes cannot be adequately expressed in a brief statement. He is under the influence of the theory that each sex contains the potentialities of the other, a conception to which it is now not easy to attach a precise, still less a factorial, meaning. He is disposed to regard the sex ultimately assumed by a given zygote as decided by a struggle or reaction taking place between two components: (1) the sex-factors brought in by X-chromosomes, and (2) a substratum conceived of as inherent probably in the cytoplasm, and capable by its own development of conferring potentialities opposite to those borne by the factors proper. To these opposing elements numerical values are assigned, arbitrarily as it appears to me, and I have been unable to discover in what way the analysis thus offered differs from a restatement of the empirically observed facts, nor is the representation of the all-male and all-female families as alternative end-products of a balanced reaction at all satisfactory. During the period covered by Prof. Goldschmidt's experiments, phenomena closely analogous have been discovered by J. W. H. Harrison in the Bistoninæ. Evidently we are thus brought into touch with a set of facts, probably abundant in nature, which must be accounted for before the problem of sex-determination is disposed of; but, paradoxical as these occurrences are, they do not justify a return to earlier stages of confusion. The problem created by the existence of intersexes, gynandromorphs, and other sex-monstrosities has always been realised. The case of the free-martin, though its true nature is now settled by the brilliant work of Lillie (well summarised in Prof. Goldschmidt's book), proves that influences as yet little understood may be taking part in these determinations.

An interesting attempt was lately made by Morgan and Bridges to apply the chromosome theory rigorously to a number of mosaic gynandromorphs which have appeared from time to time in the pedigreed work on Drosophila. The parental composition being known, it could be shown from the distribution of the sex-linked factors that in nearly every case these curious patchworks might be represented as resulting from a presumably accidental elimination of a sex-chromosome from the affected parts of the body. The result was certainly a striking one; but this interpretation is not readily applicable to intersexual forms which are not mosaics. Admitting, however, that in mosaics *something* may have been eliminated from the affected patches, the suggestion that this something is the sex-chromosome raises the questions: Why do not the miscellaneous variations, to which the chromosomes of somatic tissues are conspicuously liable, more frequently show their consequences as somatic patchworks? and, conversely, Why are the chromosomes of normally dissimilar tissues not themselves dissimilar? But, apart from difficulties to which that line of argument must immediately lead, the occurrence of the intersexes among Prof. Goldschmidt's moths can scarcely be a consequence of accidental elimination, inasmuch as they came with extraordinary regularity. Appeals to the action of "hormones," from which he hopes a good deal, are a mere veiling of the difficulty. No one will dispute that these products are part of the proximate mechanism by which the effects of sexual differentiation are produced; but the problem of sex-determination is to discover the influence which primarily causes that differentiation to proceed in one direction rather than in the other; and herein, where the evidence of gametic differentiation is insufficient, we are left without any plausible conjecture. In considering the characteristics of partly or wholly sterile forms, it may be worth remembering that in proportion as a zygote is sterile, it *may* be retaining elements which, if it were fertile, would be extruded in its gametes. May not this retention influence the characters of the zygote?

Like its predecessors, this book expressly abstains from the attempt to deal with the problem of sex-determination in plants. We cannot quarrel with the wisdom of that decision, for the truth is that we are very far from any workable scheme which can be applied to them; but it is unfortunate that the diagram put forward by Correns as a representation of his views on sex in Bryonia should be chosen as the model of a "digametic" system of sex-determination. The author does imply that he has misgivings about that illustration, which, as I have elsewhere shown, is quite inconclusive. The incautious reader could scarcely avoid the inference that the scheme of sex-determination applied to animals is one which had been proved to hold in the case of a flowering plant—a very misleading conclusion.

Another region of the subject still altogether obscure is the genetical relation of the unisexual to the functionally hermaphrodite forms in animals. Prof. Goldschmidt's book contains all that can yet be said on that difficult question. There are, of course, various sorts of monœcism, and for scarcely any of them have we yet even an acceptable cytological scheme, still less any genetical evidence.

The book, as a whole, is very well done, and may be recommended to all students who wish to have the latest presentation of the facts in a clear and readable form. As I have implied, there is a want of lucidity in the discussion of the problem of the intersexes, and trouble would be saved to the reader if he were at once told that he will not be presented with a real solution. If he reads the book carefully he will discover that for himself; but the series of facts is exceptionally interesting and, at the present stage of genetical theory, of such vital importance that the effort will not be wasted.

W. BATESON.

Anæsthetics.

Anaesthetics: Their Uses and Administration. By Dr. Dudley Wilmot Buxton. Sixth edition. (Lewis's Practical Series.) Pp. xiv + 548 + viii plates. (London: H. K. Lewis and Co., Ltd., 1920.) Price 21*s*. net.

THE appearance of this new edition is to be welcomed because great advances have been made during the past few years, and also several other text-books on this subject have been for some time out of date and even out of print.

Although the size of the new volume is not much increased, Dr. Buxton has found means to add much fresh material and to re-write a great deal of the old. The chapter on the history of anæsthetics remains one of the most readable in the book, and will repay perusal by anyone not otherwise interested in the subject.

Within the past few years, and especially during the war, many new methods of anæsthesia have been devised or perfected, and many new problems attacked with more or less success. It is naturally to the chapters dealing with these methods and difficulties that one turns with the greatest curiosity. Nothing appears to have been forgotten, and each subject is discussed clearly and as fully as the space of one volume allows. The advantages of the administration of warm anæsthetic vapours are dealt with and the apparatus is described. Perhaps the section devoted to the use in major surgery of nitrous oxide with oxygen is one of the most important to the student of to-day. The advantages of this method of anæsthesia are shown to be real, although it has no doubt suffered from the too hearty advocacy of enthusiasts. In cases of severe shock, in both military and civil practice, its merits are so great as to make its use almost obligatory. On the other hand, many anæsthetists, and certainly most surgeons, will agree that as a routine method for abdominal sections it is not suitable. Dr. Buxton wisely points out that on the count of safety alone its advantages have so far been assumed rather than proved, and he agrees with Page that in cases of marked arterial degeneration, emphysema, or obstructed air passages its use is contra-indicated.

The subject of intratracheal insufflation of ether is fully dealt with, and perhaps that of intravenous ether infusion receives more space than it deserves, as some of its leading exponents seem now to use it but little. This may be due to the more extended use of rectal etherisation combined with oil, which, although a little troublesome, has proved very useful in plastic surgery about the head, and especially in bad cases of Graves' disease.

Many subjects concerning which it has been difficult to obtain a connected account without reference to the original papers are clearly and sufficiently summarised in this edition. Among these, one notices the sections dealing with acapnia, anoci-association, acidosis, and shock with its allied conditions. Dr. Buxton is certainly to be congratulated on having not only modernised, but also improved what was already one of the very best text-books on the subject.

Mathematical Text-books.

(1) *An Elementary Treatise on Differential Equations and their Applications.* By Prof. H. T. H. Piaggio. (Bell's Mathematical Series. Advanced Section.) Pp. xvi+216+xxv. (London: G. Bell and Sons, Ltd., 1920.) Price 12*s*. net.

(2) *Elementary Algebra.* Part i. By C. V. Durell and G. W. Palmer. (Cambridge Mathematical Series.) Pp. viii+256+xlvi. (Answers.) (London: G. Bell and Sons, Ltd., 1920.) With introduction, price 4*s*. 6*d*.; without introduction, price 3*s*. 6*d*.

(3) *A Short Course in College Mathematics: Comprising Thirty-six Lessons on Algebra, Coordinate Methods, and Plane Trigonometry.* By Prof. R. E. Moritz. Pp. ix+236. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1919.) Price 10*s*. 6*d*. net.

(4) *Arithmetic.* Part ii. By F. W. Dobbs and H. K. Marsden. (Bell's Mathematical Series.) Pp. xii+163+xi. (Answers.) (London: G. Bell and Sons, Ltd., 1920.) Price 3*s*. 6*d*.

(1) OF the two volumes that head the list it is difficult to speak too highly. The scope of that on differential equations is stated most succinctly to teachers by the mere statement that it covers the course for the London B.Sc. Honours, Schedule A of the second part of the Tripos, and some of the work for the London M.Sc. and for the Tripos, part ii. The author has clear views of the equipment of the students who are likely to use the book—an elementary knowledge of the differential and integral calculus, and a little co-ordinate geometry. In the old days it was quite possible for a respectable mathematician to become, with comparatively little effort, also a respectable mathematical physicist. Owing to the remarkable extension of specialisation in both subjects, this is no longer the case. It is perhaps all the more essential that the living interest of such a branch of the subject as this should be maintained at every stage, and it is here that the crucial test is made of the powers of the mathematician who also aspires to be a great teacher. He is not content merely to "give an account of the central parts of the subject in as simple a form as possible." He is careful that the various stages of the journey shall lead to Pisgah heights from which may be viewed the Promised Land to which the adventurous may make their way, and some province or other of which, according to taste or opportunity, they may some day make their own. Nor are the names and records of the older guides forgotten, and as each fresh height is scaled historical notes give just enough to fix the chronology and to whet the appetite for further information about those who first made their own the notable peaks and crags around the young climber.

In the first chapter we are glad to see the influence of the remarkable chapters published by Dr. Brodetsky last year in the *Mathematical Gazette*, and of Prof. Wada's paper on graphical solution. Chap. iv., on simple partial differential equations, with their genesis, the construction of simple particular solutions, and the procedure from simple to complex solutions with the help of Fourier's series, is a welcome innovation at so early a stage.

Chap. vi., on singular solutions, abandons any attempt at an analytical treatment at this stage of the student's development, and appeals to geometrical intuition. Chap. ix. deals with solution in series, following the method of Frobenius. Here we find among the examples the equations associated with the names of Bessel, Legendre, and Riccati, with a sketch of the hypergeometric equation and its twenty-four solutions. The nature of an existence theorem is explained in chap. x. The methods of Picard and Cauchy are followed by a discussion of the method of Frobenius, and here plentiful references are given for the benefit of those whose knowledge of the theory of series is inadequate. The references, indeed, are plentiful throughout. We may note one that is of little use to many of us—Stodola's "Steam Turbine," which has been unobtainable for some time past. In the miscellaneous examples the author, in a large number of cases, adds to the theorems to be solved the physical applications.

An appendix contains useful references for further reading.

By a strange oversight, chap. v. begins with types of equations "solvable for p," where not only has p not been defined, but the letter has also been repeatedly used on previous pages in different senses. Of course, the third line in ex. i. of paras. 52 and 53 will reveal the new signification to a smart reader, though the private student, as a rule, will be completely at sea for a time. There are other minor points, which will, no doubt, be attended to in the second edition; but space forbids us to say more than that, in this most interesting volume, Prof. Piaggio has proved himself to be a teacher of remarkable insight and skill.

(2) We know of no better introduction to the elements of algebra than that by Mr. Durell, of Winchester, and the late Mr. Palmer, of Christ's Hospital. The authors have contrived a course in which there is scarcely a page without ample evidence of intimate care controlled by a profound knowledge of youthful psychology. To many, the greatest attraction in the book is the fact that so large a proportion of it is adapted for *viva voce* work, and in accordance with modern ideas the material is throughout selected so as to bring the pupil as soon as possible within sight of the applications of the subject to the affairs of everyday life, and to such elementary scientific work as may be fairly expected to have come within his experience. The usual explanatory matter, which few boys and girls ever read, is reduced to a minimum, and placed in an "introduction" of about twenty pages. Useful extensions of various sections for the benefit of the few irrepressibles who cannot be kept back, and for the budding engineers and future specialists, are added in a final chapter. The writer of this notice can speak with personal experience of the successful manner in which a training on these lines copes with the inertia which lies at the base of most, if not, indeed, of all, of the difficulties that confront the beginner. In the hands of a sound teacher the pupil's rate of progress will be as rapid as he chooses, and the book may be placed with confidence in the hands of the private student. The collection of sixty odd pages of well-graded revision papers of various stages of difficulty adds considerably to the general value of the book.

(3) The short course of college mathematics by Prof. Moritz, professor of mathematics in Washington University, was originally devised to meet the demand during the war for short courses. So far as it goes, the treatment is thorough; the sixty pages on graphic methods are well and plentifully illustrated, and the student who has mastered the book should have a sound grasp of the essentials of trigonometry.

(4) The second part of Messrs. Dobbs and Marsden's "Arithmetic" consists of collections of papers, with the minimum of explanatory text, covering easy mensuration, financial subjects, graphs, and applications of elementary arithmetical notions to such problems as specific gravity, map-reading, etc. About half the book is given to revision papers. There is considerable variety in the carefully selected sets of questions.

Our Bookshelf.

Heredity and Evolution in Plants. By C. Stuart Gager. Pp. xv+265. (Philadelphia: P. Blakiston's Son and Co., 1920.)

THIS little book is an expansion of several chapters of the author's "Fundamentals of Botany." It is intended for beginners and general readers, and presents in a fresh way a very readable and well-illustrated account of the phenomena of heredity and evolution from the strictly botanical point of view. The author begins quite unexpectedly with two chapters on the life-history of a fern, and this concise account, followed by a chapter on fundamental principles, forms a background for the treatment of the subject proper. The definition of heredity as "the genetic relationship that exists between successive generations of organisms" omits to recognise the fact that the conception of heredity is fundamentally concerned with resemblances and differences as they occur in genetically related organisms. Later chapters deal with Mendelism, evolution, Darwinism, and experimental evolution. A very good balance is preserved between the historical and the descriptive methods, with a sprinkling of illustrations, the majority of which are new to text-books.

A chapter on the evolution of plants touches upon such problems as alternation of generations, evolution of the sporophyte, and the evidence from comparative anatomy, and ends with a hypothetical ancestral tree of relationships. One of the subjects best treated is that of geographical distribution, which discusses the means of dispersal, peculiarities of distribution, effects of glaciation and cultivation on distribution, endemism, the "age and area" hypothesis of Willis, etc., with numerous illustrative cases from the recent literature. The final chapters deal with the fossil record and the various hypothetical relationships of the groups of vascular plants.

The book is well produced and relatively free from typographical errors. We notice a slip (p. 42) in the statement regarding the multiplication of the offspring from a mustard plant. Many general readers will find enjoyment and information in a perusal of this little book.

R. R. G.

Practical Chemistry: Fundamental Facts and Applications to Modern Life. By N. H. Black and Dr. J. Bryant Conant. Pp. xi + 474. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1920.) Price 11*s*. net.

THE title of "Practical Chemistry" might lead to the impression that the book, written by two American teachers, was a laboratory manual. That is not the case. The text-book is an admirably clear and interesting introduction to chemistry, in which, it is true, the practical applications of the subject are not neglected. The attitude of the authors is completely modern, and the appearance of the book is greatly improved by numerous well-executed illustrations, and reproductions of photographs of actual plant and apparatus used in industry. Portraits of famous chemists, brief historical details, and numerous experiments are given. At the end of each chapter is a list of "Topics for Further Study," which often contain interesting suggestions. Any attempt to stimulate thought is welcome in a text-book, and the present volume is rich in such efforts.

In addition to a careful and accurate account of the familiar topics, many recent discoveries are included in a very readable manner. For instance, accessory factors in diet, the purification of water by chlorine, the hydrogenation of oils, the cleansing power of soap, and the really practical processes used in the fixation of nitrogen are all discussed in sufficient detail to make them intelligible. A useful summary is added to each chapter, together with a list of interesting questions. The authors are to be congratulated on producing a really interesting book; clear and accurate, with a freshness of treatment which is grateful to the hardened reader of elementary text-books. As an introductory text-book for elementary students, and for use in the higher forms of schools, this may with confidence be recommended.

J. R. P.

Physiology. By Dr. Ffrangcon Roberts. (Students' Synopsis Series.) Pp. viii + 389. (London: J. and A. Churchill, 1920.) Price 15*s*. net.

THE student of physiology has such a wide choice of text-books dealing more or less exhaustively with the subject that the entry of a new volume into the list might be regarded as unnecessary. This book, however, is intended to meet a special need incurred by the growth of the science. The application of physical and chemical methods to the elucidation of the problems of the body, the war-time accumulation of new facts and ideas, and the advances in the sister sciences have so altered the material and increased the size of the new editions of the standard text-books that an orderly arrangement is in danger of being obscured by the mass of detail. This is a real difficulty to the student, and furnishes a valid reason for the issue of this volume of the Students' Synopsis Series. The book is definitely intended to supplement, and not to supplant, the larger text-books. It assumes that the student has already an acquaintance with the elements of physiology and has had some experience of practical work. It also assumes that he has a considerable knowledge of physics and chemistry, without which its treatment of such a topic as the reaction of the blood, though ably presented, would by its brevity fail to convey the necessary instruction. The book admirably fulfils its purpose, and Dr. Roberts is to be congratulated upon his success in accomplishing the difficult task of compiling a summary of the salient facts of physiology which is readable, clear, concise, and up to date. The volume is well edited and its illustrations are apposite.

P. T. HERRING.

Landscape Architecture. By Prof. H. V. Hubbard and Theodora Kimball. Pp. 132. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1920.) Price 6*s*. 6*d*. net.

THIS work sets out to provide a comprehensive classification of the field of landscape architecture, and attempts to show in detail both the "subjects making up the field, and the relation of the field itself to tangent fields." The scheme resolves itself into a series of some thirteen to fourteen hundred headings, under which published literature, notes and other manuscript material, maps, plans, photographs, and other pictorial matter may be arranged. These headings are placed in groups according to their relationship with each other, and the groups themselves are classified. Landscape art must be much more highly organised in the United States than it is here to justify the publication of such an elaborate scheme as this, the chief *raison d'être* of which is the convenient docketing of papers in one form or another. We doubt if there are half a dozen firms of landscape gardeners in this country whose accumulation of material is so extensive as to need extraneous assistance in arranging it, but to any such this work is no doubt capable of affording valuable suggestions. It shows, at any rate, how extensive is the area covered by landscape art, and how far-reaching are its ramifications when followed out to their full extent.

W. J. B.

Nucleic Acids: Their Chemical Properties and Physiological Conduct. By Prof. W. Jones. Second edition. (Monographs on Biochemistry.) Pp. viii + 150. (London: Longmans, Green, and Co., 1920.) Price 9*s*. net.

SINCE the first edition of this monograph was reviewed in NATURE for April 1, 1915, our knowledge of physiological chemistry has been considerably extended. The four hypothetical nucleotides required by the nucleotide theory of the structure of plant nucleic acid have now been prepared, and new facts regarding the purine fermentation in various animals have been brought to light. The work concludes with a bibliography of no fewer than twenty pages.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Arrangement of Atoms in Crystals.

IN NATURE for January 6, p. 609, was published a note in which some figures given in my paper on "The Arrangement of Atoms in Crystals" (*Phil. Mag.*, vol. xl., August, 1920) were contrasted with similar figures given by Wyckoff (*Amer. Journ. Sci.*, [iv], vol. l., pp. 317–60, November, 1920). These figures were estimates of the distances between atoms of metal, carbon, and oxygen in the crystals calcite, $CaCO_3$, rhodochrosite, $MnCO_3$, and siderite, $FeCO_3$. In this note it is stated that our data differ considerably, "the deviations rising to 0·6 Å. in the distance from carbon to metal."

There are no discrepancies of this magnitude between Wyckoff's results and mine. The large differences to which the note directs attention are due to errors in quoting the results given in my paper, owing, I think, to a misconception of the structure which Wyckoff and I agree in assigning to these crystals.

I give the correct figures, the distances being expressed in Angstrom units:

	Wyckoff.		Bragg.	
	I.	II.	Experimental	Sum of radii
Ca–O ...	2·30	2·42	2·30	2·35
C–O ...	1·21	1·28	1·42	1·47
Ca–C ...	3·04	*3·206*	*3·206*	
Mn–O ...	1·96	2·13	2·10	2·11
C–O ...	1·22	1·32	1·42	1·47
Mn–C ...	2·83	*3·072*	*3·072*	

If I understand Wyckoff's results rightly, we are in agreement as to the type of structure in the case of these carbonates, and the symmetry of the crystal alone suffices to fix the positions of the calcium and carbon atoms. The distance between them can be calculated from the molecular volume of calcite, Avogadro's number N, and the crystal axial ratios. The dimensions of the calcite structure have been made the subject of careful investigation (Uhler, *Phys. Rev.*, July, 1918), as it has been used for standard X-ray wave-length determinations. Taking the value $d_{(100)}=3·028$ Å. given by Uhler, it follows that this distance from calcium to carbon atoms is 3·206 Å. Wyckoff gives the value 3·04 Å., and so ascribes to the whole structure a smaller scale. If, as I believe, his scale is too small, all his figures should be increased in the ratio 3·206 to 3·04. A similar increase of scale holds for rhodochrosite. Under I. are given Wyckoff's values, and under II. those values increased in what I believe to be the correct ratio.

Wyckoff gives figures which differ from mine for the distance between carbon and oxygen atoms. He has made a very careful determination of a certain parameter (denoted by "u" in his paper), and I believe his value for it, 0·25, to be much more trustworthy than my approximate value 0·30. Wyckoff's value confirms a determination 0·25–0·27 by W. H. Bragg (Trans. Roy. Soc., A, vol. ccxv., pp. 253–74) in 1915—a determination which I did not know when I published my figures. If the figures in column II. are accepted, this would mean that my estimate of the "diameter" of carbon in compounds is too high, and that a better value would be nearer that of fluorine, 1·35 Å. This is the only serious discrepancy between our results, and it does not seem to me that it affects in any way the general conclusions which I drew in my paper.

The figure 2·47 Å., quoted as being given by me for the distance Ca–C, has presumably been arrived at by the author of the note by adding the radii for these atoms. As they are partially separated by the oxygen atoms which surround the calcium atom, there is no direct connection between the sum of the radii and the distance between them. I used in my calculations the theoretical value obtained as above.

May I take this opportunity to correct another error in the note? The figures given for the "diameters" of the electro-negative elements are quoted correctly from my paper, but those given for the metals are one-half the value which I gave under this head.

W. L. BRAGG.

Manchester University, January 22.

A Case of Coloured Thinking with Thought-forms and Linked Sensations.

COLOURED thinking is such a peculiar condition that those interested in it will welcome the details of a well-marked case of it. It must be distinguished from linked sensations such as coloured hearing—one of the synæsthesiæ—in which heard sounds call up colours, as when the low notes of the organ suggest violet or the high notes white or yellow, etc.

Coloured thinking or chromatic mentation (psychochromæsthesia) is the visualising of concepts as coloured, the ability to think of a letter of the alphabet, a number, a date, a month, or a name as associated with some colour or other—white, black, red, green, etc. To those who have never experienced this sort of thing it is unintelligible.

One coloured thinker thus expressed himself: "When I think at all definitely about the word January the name appears to me reddish, whereas April is white and May yellow; the vowel 'i' is always black, the letter 'o' white, and 'w' indigo-blue. Only by a determined effort can I think of 'b' as green or blue, for to me it has always been and must be black; to imagine August as anything but white seems to me an impossibility, an altering of the inherent nature of things."

Of course, the same person who has coloured hearing—the commonest of the linked sensations—may likewise have coloured thinking, although most coloured thinkers do not also have linked sensations. The case the interest of which I think sufficiently great to report on now is one both of linked sensations and of coloured thinking. But there is also a third element of interest in it, namely, that of thought-forms. A thought-form or psychogram is the visualising of, say, the numerals or letters of the alphabet or months of the year in such a way that they seem to form some definite figure in space—for instance, an arc of a circle or a ladder sloping up to the right or left, and so forth. A psychogram is the uncoloured form of a concept or a series of them; the psychochrome is the concept itself exteriorised in colour.

The case the coloured thoughts, linked sensations, and thought-forms of which I subjoin is that of a student of this University (Miss A. M.), who has all the features characteristic of these cases. She has been a coloured thinker ever since she can remember; the colours have not altered with lapse of time, they are exceedingly definite, they do not agree with the colours seen by other thinkers for any one given concept, and, finally, the "seer" cannot account for them in any way.

The only feature in the present case not quite typical is that it is not so clearly hereditary as is usually observed. Miss A. M. says that neither of her parents is a coloured thinker, though her "mother associates colours with the characters of people." This has been called "individuation," and is not so uncommon as might be imagined.

The classic discussion of this sort of thing is to be found in Sir Francis Galton's "Inquiries into Human Faculty and its Development" (London, Macmillan, 1883). This has been reprinted in Everyman's Library. Since that time very little has been written in English on the subject. With the exception of a letter in Nature (vol. xliv., p. 223, 1891) and two papers by Miss M. A. Calkins in the *American Journal of Psychology* (1892), there has been nothing published on the subject until my articles in 1905 and 1908 respectively appeared in the *Edinburgh Medical Journal* and in the *Journal of Abnormal Psychology* (Boston, U.S.A.). The *British Review* of April, 1913, published a popular account of colour-hearing by C. C. Martindale.

D. Fraser Harris.

Dalhousie University, Halifax, Nova Scotia,
December, 1920.

Appendix.

Coloured Concepts or Psychochromes of Miss A. M.

a, creamy-white; b, shade clearer than "d"; c, pink; d, indigo, dirty (gritty) blue; e, black (wet); f, dry brown; g, black on white; h, darkish fawn, like chocolate blancmange; i, black; j, dirty, pearly, bluish-white; k, clear brown, edged with mustard-yellow; l, yellow; m, jade-green; n, pea-green; o, black; p, darker green, bluer; q, black, with red tinge; r, dry red; s, crimson, scarlet; t, deep black-red; u, dark grey, almost black; v, very dark navy, blue and green; w, not so dark, green and navy; x, brownish-mustard-yellow, very ugly; y, almost neutral bluish-green; z, like "x," but a little yellower.

Sunday, golden-yellow, with a fleck of green in the middle; Monday, pretty light green; Tuesday, dark blue with red flecks; Wednesday, soft, deeper green; Thursday, like Tuesday, with more red; Friday, brown, soft like suède gloves; Saturday, bright scarlet.

January, clear, intense pale green, like ice; February, dirty light reddish-brown; March, green and red at end; April, fresh, pale yellow; May, very pale green, almost white; June, green; July, yellow and royal blue; August, golden-yellow; September, red and brown (autumn); October, navy blue; November, brown with yellow edges; December, dirty, almost colourless, made up of black, navy blue, and dark green.

Christmas, pink (Christ), red and green (mas); Easter, creamy-white.

1, black; 2, creamy-yellow; 3, red, pale; 4, brown; 5, bright, wet red; 6, dull indigo; 7, ugly yellow; 8, white; 9, green; 10, black; 11, black and yellow; 12, creamy-yellow.

The twenties, yellow; the thirties, reddish; the forties, brown; etc. The hundreds are the same.

Synaesthesiae.

Pains have colours, but following the colours of the names, *i.e.* sore, red; ache, opaque-whitish; sprain, greenish-red; cut, blue and red; bruise, blue and red.

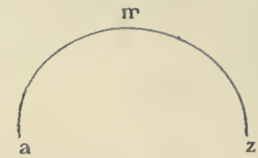
Tastes are only slightly coloured: acid are sharp, penetrating yellow; sweet, soft yellow. Odours, only slightly, either grey or yellow: a musty smell is grey and red; acrid, yellowish-grey. Touch, not at all: heat is yellow, and different degrees different shades up to a pure white, which is cold.

Music is the only thing that makes Miss A. M. see purple and violet. Deep organ notes blend from blue to purple, but only music. Even the names "purple" and "violet" she sees only by the letters which make them up. If "violet" had not a "t" at the end it would be merely dark blue, and the same with the "r" in purple. The lowest organ notes are, to her, deep purple, like a bruise, while the very high notes are yellow and pink.

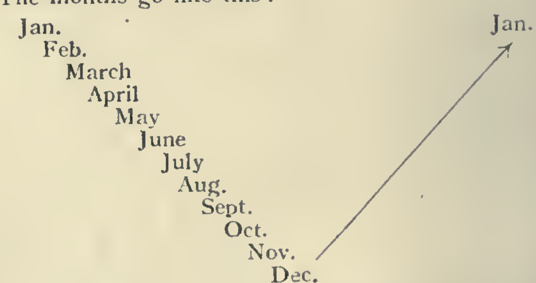
Psychograms.

Numerals go like this:

The alphabet goes like this:



The months go like this:



The week between Christmas and New Year's Day stretches back to January.

Days of the week go like this:

Sat. Sun. Mon. Tues. Wed. Thurs. Fri. Sat.

Heredity and Acquired Characters.

Mr. J. T. Cunningham remarks (Nature, January 13, p. 630): "Provided that biologists understand one another, it is, perhaps, not an insuperable barrier to the progress of biology that Sir Archdall Reid is unable to understand their terminology." Prof. MacBride declares (*ibid.*): "I have attended many congresses of biologists, and I have never found evidence of confusion in their minds as to what was meant by an 'acquired character.'" I feel humbled, but not enlightened.

As far as I am able to understand Mr. Cunningham's letter, he regards as "acquired" everything which develops in response to use, and everything else as "innate." Herein he agrees with Lamarck and Sir Ray Lankester, but differs from a host of other writers, including Spencer, Wallace, Romanes, and Weismann, all of whom regarded the effects of injuries as "acquired" characters. He differs even from himself, for he has, when arguing in favour of the transmission of acquirements, attributed the evolution of antlers to the effects of irritation (injury). He differs in the same issue of Nature from Prof. MacBride, according to whom "'acquired character' is a technical term; by it is meant a quality, *i.e.* the degree of development of an organ, which is produced as a response to function, altered from the normal in response to an alteration of the environment from the normal." Whence it follows that, while Mr. Cunningham would term the muscular development of the ordinary man "acquired," Prof. MacBride would call it "innate," and would limit the term "acquired" to such developments as the blacksmith displays. If everyone worked as blacksmiths, Prof. MacBride would differ still more from Mr. Cunningham, for the whole of development would then be termed by the former "innate" and by the latter "acquired." To Mr. Cunningham the English language is always an acquirement; to Prof. MacBride it is innate if learned in England, but acquired if learned in France.

Formal definitions of the meanings of the terms "innate" and "acquired" when applied to characters are extremely rare in biological literature—unless such terms as "germinal" and "somatic" be attempts at definition. However, Romanes made the attempt. This is what he says ("An Examination of Weismannism," p. 5): "By a congenital character is meant any individual peculiarity, whether structural or mental, with which the individual is born. By an acquired character is meant any peculiarity which the individual may subsequently develop in consequence of its own individual experience." Elsewhere (p. 214) he defines congenital (plasmogenetic) characters as "variations due to admixtures of germ-plasm in acts of sexual fertilization (and, therefore, present at birth), as distinguished from somatogenetic characters—variations which have been acquired independently of germ-plasm." Somatic characters he defines as "characters acquired by the soma (*i.e.* variations acquired after birth by the action of the environment), as distinguished from characters produced and potentially present from the first by a union of two masses of germ-plasm—plasmogenetic characters." Romanes's language may be lacking in precision, but evidently he supposed that there is something peculiarly "innate" about a "germinal" character and something peculiarly "acquired" about a "somatic" character. Unlike Prof. MacBride, he gives all these terms their ordinary or dictionary meanings—and so, I believe, do most biologists.

Dr. Ruggles Gates (NATURE, January 20, p. 663) believes I contradict myself. It is possible he has not grasped my meaning. An illustration may help. Before me are two pencils. Comparing these individuals, I find that their differences as regards length are great, but as regards colour small. Dr. Gates will agree that I am not entitled to transfer the terms by which I described the differences between the individuals to the characters wherein they differ—*i.e.* I am not entitled to call the lengths of the pencils great and their colours small. That way lies confusion of thought. Now consider two living individuals, the one an Englishman and the other a scarred negro. They differ in colour innately—they are in this respect by nature different; their germ-plasms are unlike; even if reared under exactly similar conditions of nurture they would be unlike. They differ in scars by acquirement; here they have had not unlike natures, but unlike nurtures; if reared under similar conditions they would be like. In brief, the colour difference is blastogenic, while the difference in scars is somatogenic. All this is intelligible; the words are used correctly. They are given their ordinary meanings; they are not in the least technical. But are we now entitled to transfer our descriptive terms from the differences between individuals to the characters in which they differ? Are we entitled to call skin-coloration "innate" and scars "acquired"? We are now comparing, not separate individuals, but the characters wherein they differ. In effect, we are comparing the characters of the same individual. How is skin-colour more innate and less acquired than a scar? They are both ancient products of evolution, both depend on germinal potentiality, both develop in response to some form of nurture, and both are situated in the soma.

Dr. Ruggles Gates writes: "I pointed out (NATURE, December 2, p. 440) that if his contention that all characters are both innate and acquired in exactly the same sense and degree is true, then it would follow that all variations are also of one type, while experimental biologists are universally agreed that this is not the case. At least two categories of variations are postulated . . . blastogenic and somatogenic. . . . Yet Sir Archdall Reid's only attempt to answer my criticism that the universally admitted existence of two types of variations undermines his whole position is the very weak one of quoting Darwin's tentative theory of pangenesis." But I did not quote the theory of pangenesis *against* Dr. Gates; I was merely trying to make my meaning clear. And surely the word "variation" indicates, not a character as such, but a difference between individuals. Resemblances do not necessarily exclude differences. A cleft lip is always a character in both man and rabbit; but it is a variation in the former, but not in the latter. A sixth digit resembles all other digits in that it is a product of nature and nurture; and yet (if the parent has it not) it is none the less a variation. So also a sixth digit resembles a scar in that it is a product of potentiality and stimulus; and yet it differs from the latter in that the unlikeness from the parent is innate, whereas it is acquired in the case of the scar. The resemblances between the two do not necessarily eliminate their differences. How, then, is my whole position undermined?

G. ARCHDALL REID.

9 Victoria Road South, Southsea.

Man and the Scottish Fauna.

I AM grateful to your reviewer (NATURE, December 30, 1920, p. 568) for his appreciation and for pointing out slips and misprints in my "Influence of Man on Animal Life in Scotland," but on some points of fact I would venture to disagree with other of his remarks.

Geologists will not be perturbed by his difficulty in believing in the persistence of evidence of man's presence in Scotland from times earlier than the formation of the 25-ft. beach. Sections of many places have shown that the 25-ft. beach, of estuarine material, *rests upon* the boulder clay, so that it is certainly not "clear that the land ice was grinding over all after the elevation which formed the younger 25-ft. beach." On the contrary, the evidence is that the 25-ft. beach was formed subsequent to the disappearance of the ice-fields. The relations of the 50-ft. beach are not so clear, but facts have to be explained on reasonable suppositions. And the occurrence of kitchen-middens of molluscan shells along the ridge of the 50-ft. beach in the Forth Valley is more easily accounted for on the supposition I have advocated—that they were collected while the 50-ft. beach was still a sea-margin—than on that of your reviewer, who would have the kitchen-middeners collect their shell-fish on the sea-side, now a great distance away, and thereafter scale first the 25-ft., and afterwards the 50-ft., beach before sitting down to their simple meals.

On the strength of a reference by Thomas the Rhymer, your reviewer suggests that I have erroneously omitted the green woodpecker from the list of banished Scottish animals. But both ornithologists (such as Yarrell and Newton) and etymologists (as in Wright's "Dialect Dictionary") are agreed that the word "wodewale," on which the whole value of the citation hangs, is a general word for a woodpecker, and applied to the great spotted as well as to the green woodpecker. The word has no specific significance. There seems to be, indeed, no evidence, past or present, that the green woodpecker has been a native of Scotland.

In naming the brown trout *Salmo trutta*, I followed the considered opinion of such an expert in fish nomenclature as Mr. C. T. Regan, of the British Museum (Natural History); my statement regarding the success of the introduction of Loch Leven trout to New Zealand did not pretend to record any *first* achieved success, and as it stands is correct; and the two "caricatures, and poor at that," specified by your reviewer happen to be reproduced from photographs of specimens mounted by skilled taxidermists, and now exhibited in the Royal Scottish Museum.

JAMES RITCHIE.

I SHOULD be sorry indeed if, in reviewing his book, I had given Dr. Ritchie the impression that I undervalued it as a contribution to prehistoric research. I did no more than express difficulty in accompanying Dr. Ritchie to the full extent of his conclusions, and surprise that, from first to last, he takes no notice of the 25-ft. beach.

I admit that I expressed myself too positively in saying that it was "*clear* that the land ice was grinding over all after the elevation which formed the younger 25-ft. beach." But many years of personal examination of the features of the Scottish seaboard have left on my mind a strong impression that some agent more powerful than sub-aerial denudation has masked or obliterated by far the greater extent of the 50-ft. beach. Such an agent may have been subsidence, glacial action, or "trail" (earth thawing and flowing after prolonged freezing, as in the "earth-glaciers" of the Rockies).

Some support to this view may be found in the late Prof. James Geikie's Munro lectures, "Antiquity of Man in Europe," 1914: "At the head of Loch Torridon well-formed terminal moraines rest directly upon the 45–50-ft. beach" (p. 273).

Prof. Geikie considered (p. 279) that the formation of that beach was followed by "partial subsidence," and continued:

"We cannot actually demonstrate that snowfields and glaciers reappeared at this stage. . . . Nevertheless, we are not without evidence suggestive of the appearance at this time of inconsiderable glaciers amongst our highest mountains. These glaciers undoubtedly existed at a later date than the glaciers that dropped their moraines on the 45–50-ft. beach. It is therefore only reasonable to infer that the high-level corrie glaciers in question were probably contemporaneous with the formation of the 25-ft. to 30-ft. beach."

The occurrence of kitchen-middens on the 50-ft. beach can scarcely be taken to prove the presence of man when the sea stood at that level. On the summit of the Fell of Barhullion in Wigtownshire, 450 ft. above the present sea-level and $1\frac{1}{2}$ miles distant from the nearest beach, are the remains of a fortified enclosure. The refuse-heap of this encampment contains a large quantity of limpet-shells. Loch Spouts, in Ayrshire, is on high ground two or three miles from the sea. Dr. Munro has recorded that when the crannog in that swamp was explored, in the midden were found "large quantities of the shells of whelks, limpets, and hazel-nuts" ("Lake-dwellings of Europe," p. 420).

Prof. Geikie cited the discovery of a canoe near Perth as evidence that Neolithic man was in occupation when the sea washed the 50-ft. beach. I have been unable to find any detailed record of the finding of this canoe, and if, as Prof. Geikie says, it was made of pine, I should hold that to be incompatible with very high antiquity. Having taken part in the excavation of many crannogs, I have never seen any submerged timber, except oak and yew, that retained a firmer consistency than cheese.

Dr. Ritchie expresses the opinion that "there seems to be . . . no evidence, past or present, that the green woodpecker has been a native of Scotland." In Wallis's "History of Northumberland," 1769, vol. i., p. 319, it is stated that this species "has been observed in some of our vale-woods, but is not common. It was frequent in Dilston Park before the wood was cut down." Two instances of its occurrence in the valley of the Tweed are recorded in Mr. Evans's "Fauna of the Tweed Area," p. 109. Dr. Ritchie seems to be in error in attributing to Newton and Yarrell the use of the name "woodwall" as a generic term for all three British species of woodpecker. Yarrell strictly confines it to the green woodpecker, though he admits that Willughby and Ray use the term in a looser sense ("British Birds," third edition, vol. ii., p. 149), while Newton merely mentions it among the popular names for woodpeckers in general. The great and lesser spotted woodpeckers do not utter any song or bell-like note, and it seems fairly clear that it is the green woodpecker that figures in the ballad of Robin Hood (*cura* Ritson):

The Woodwele sang and would not cease,
Sitting upon a spray,
So loud he wakened Robin Hood
In the Greenwood where he lay.

It is probable that the green woodpecker, yaffle, or woodwale disappeared from Scotland with the forest that sheltered it.

THE REVIEWER.

Literature for Men of Letters and Science in Russia.

AT the beginning of this year an appeal was issued for funds to enable a certain number of scientific and literary publications to be sent to the House of Science and the House of Literature in Petersburg, where the remnant of the intellectual life of Russia is mostly congregated. The British Committee for Aiding Men of Letters and Science in that country has assured itself that such publications will reach their destination, and has made arrangements for their transmission. There are probably many authors who would be willing to send copies of their works in the form of excerpts or otherwise to Russian workers who have been cut off from the outside world since the revolution. The British Committee will be glad to receive any such books or papers of a non-political type and to send them to Petersburg. It cannot guarantee delivery to individuals, but it can ensure that publications will reach the Houses of Literature and Science. Parcels for transmission should be addressed to the above Committee, care of Messrs. Wm. Dawson and Sons, Ltd., Continental Department, Rolls Buildings, Fetter Lane, E.C.4.

L. F. SCHUSTER.

British Science Guild Offices, 6 John Street, Adelphi, London, W.C.2, January 26.

The Mild Weather.

APROPOS of Mr. Charles Harding's letter (NATURE, January 20), one result of the extraordinary weather in the south of England since the third week of December was that on January 24 I saw forty or fifty plants in flower of the minute Crucifer (*Hutchinsia petraea*) on limestone screes close to Bristol. Some of the seedlings were 2 in. high, with five or six flowering heads and with seed-pods already developed. Last year a few were in flower on February 12, but even this is remarkably early, for March–April is the usual time in the district for this rare plant, and most of the books give March–May. On January 5 I saw a hazel in full blossom between Gunnersbury and Kew.

H. STUART THOMPSON.

5 Westbourne Place, Clifton, January 30.

The Forest Resources of India.[1]

MORE than one-fifth of the total area of British India (including the Shan States), comprising some 250,000 square miles, is under the control of the Forest Department. In this vast area the diversity of climate, soil, and vegetation is very great. The forest vegetation ranges from that of the arid, semi-desert tracts of North-west India and the alpine scrub on the higher slopes of the Himalayas to the luxuriant evergreen forests of parts of Assam, Burma, and the west coast of India, while the total number of woody plants comprises approximately 5000 distinct species. The number of valuable timbers and other commercial products available in the forests is very large, and many of them are as yet imperfectly known. Among the best-known timber trees are red cedar (*Cedrela Toona*), deodar (*Cedrus deodara*), satinwood (*Chloroxylon Swietenia*), rosewood (*Dalbergia latifolia*), padauk (*Pterocarpus dalbergioides*), sandal (*Santalum album*), sal (*Shorea robusta*), and teak (*Tectona grandis*). The principal minor products are classified under bamboos, grass, fibres, oil-seeds, tanning materials, essential oils, gums, resins, rubber, drugs, and lac. Minor forest industries which are likely to develop considerably in the near future are the paper-pulp industry, which offers great scope for the utilisation of bamboos and grasses, and the production of turpentine and rosin from the resin of *Pinus longifolia*. During the last twelve years the Indian resin factories have increased their output tenfold.

FIG. 1.—Main building of the Forest Research Institute, Dehra Dun. From "The Work of the Forest Department in India."

Forest crops usually require long periods of time to attain maturity, and the effect on growth and development of any particular method of treatment often only manifests itself after a number of years. The forest officer, therefore, who can himself rarely hope to see the full results of his own work, must possess in an unusual degree the qualities of patience, imagination, and foresight, and must, as a rule, be content with the knowledge that he is working for the good of posterity. The early efforts of forest officers in India to demarcate and protect the forests from destruction, and, by careful treatment, to enable

[1] "The Work of the Forest Department in India." Prepared under the direction of the Inspector-General of Forests to the Government of India, April, 1920. (London: Harrison and Sons.) Price 1s.

the forests to produce a regular and increasing supply of timber and other products, met with much bitter opposition from short-sighted commercial interests and from the local population which had been accustomed to regard the forests as the free gift of Nature. The present generation, however, is enjoying the fruits of the labours of devoted pioneers, who in the face of great opposition have built up "a property of constantly increasing value, the future importance of which it is hardly possible to over-estimate." In view of the general apathy regarding scientific forestry which prevailed in Great Britain itself until the vital importance of forest resources was emphasised by the recent war, it is indeed remarkable that during the last seventy years the importance of forestry in India has been steadily kept in view by British administrators. In this respect, indeed, India may well claim to have set a worthy example to the rest of the British Empire.

The most noteworthy event in the early history of scientific forestry in India was the enunciation of a definite and far-sighted forest policy by Lord Dalhousie in 1855, which was followed by the appointment of Dr. Brandis as Superintendent of Forests in Pegu in 1856. In 1874 the superior forest staff consisted of seventy-one officers; in 1918 this number had risen to 257, while schemes now under consideration are expected to raise this figure to 350. It is instructive to compare with these figures the following details of the average annual surplus forest revenue, in lakhs of rupees, during the quinquennial periods mentioned:

Period	Revenue
1864–68	13·6
1869–73	17·0
1874–78	20·8
1904–08	116·0
1909–13	132·3
1914–18	160·2

The value of Indian forest resources, however, must not be judged mainly by financial results. The first duty of the Forest Department is to provide the ordinary domestic and agricultural requirements of the local population in respect of timber, fuel, grass, grazing and other products. Large quantities of such produce are utilised by right-holders and free-grantees, while in times of famine the people are often largely dependent on the forests for their existence. The forests also provide congenial employment for a considerable portion of the population, and it is estimated that some five millions of people in India are directly or indirectly dependent on forestry for their livelihood for the greater part of the year. In many cases, also, the primary object of the forester in establishing and preserving forest vegetation is

FIG. 2.—Teak plantation eighteen months old at Kaptai, Chittagong tract. From "The Work of the Forest Department in India."

to prevent injurious erosion and to regulate the storage of rainfall.

The future development of the forest resources of India depends chiefly on three factors:

(1) Creating or increasing the market for individual products. Valuable work in this direction was done at the recent Empire Timber Exhibition by emphasising the uses and handsome appearance of several common Indian timbers, which hitherto were practically unknown in home trade circles. This kind of work necessitates, on one hand close co-operation between forest officers and the commercial world, and on the other co-operation between forest officers and those men of science who are engaged in studying the properties of forest products. With reference to the latter point, recent progress has been made by attaching a cellulose expert (to investigate paper-making materials), a tannin expert, an expert in wood-technology, and others, to the Forest Research Institute at Dehra Dun.

Fig. 3.—Bamboo rafts at Ma'ne Muk, Kasalong river, Chittagong hill tract. From "The Work of the Forest Department in India.

(2) Providing improved transport facilities in the shape of roads and mechanical appliances with the object of lessening the cost of extraction and making it possible to work areas which are at present inaccessible. An important step recently taken in this connection is the addition of a special engineering branch to the Indian Forest Department.

(3) Improved methods of sylvicultural management, the success of which primarily depends on research work carried out by sylviculturists, botanists, zoologists, chemists, and other men of science with the object of increasing available knowledge regarding the requirements of individual species, and the factors which favour or impede their healthy growth and development. Such work is the bed-rock of all truly progressive forestry. It is of little use to build up a market for a product unless a sustained supply of it can be assured and concentrated on those areas where its exploitation can be provided for most efficiently and at a minimum cost. Moreover, until a detailed knowledge of the requirements of individual species has been acquired, the maximum yield of any particular product cannot be obtained. That there is much to be done under this head is evident from the fact that, although the conditions of soil and climate over a large part of the forest area in the Indian Empire are exceptionally favourable to vegetative growth, the present yield from the best of the Indian forests is considerably below that of intensively worked European forests. That the importance of this kind of work is not being overlooked by the Indian forest authorities is indicated by the fact that at the Forest Research Institute, which was established at Dehra Dun in

1906 at the instance of Sir S. Eardley Wilmot, provision was made for research work in sylviculture, forest botany, zoology, and chemistry, as well as in forest economic products. A scheme now under consideration contemplates a large increase in the establishment and equipment of this institute, involving the acquisition of a site of 1000 acres and an expenditure of some 500,000*l*.

It is interesting to note that, as the work of the Forest Department has increased in volume and complexity, the organisation which sufficed when forest work was relatively simple and of a routine nature has proved to be no longer suitable, and in recent years there has been a considerable advance in the direction of decentralisation. Thus the major provinces now have complete control over their forest revenue and expenditure, while the provincial chief conservators carry out many of the duties which previously were performed by the head of the department. Similarly, it is now recognised that a great deal of research in sylviculture and economic products must be carried out by local officers in the provinces, and not by the staff of the Central Research Institute at Dehra Dun. At the same time, the value of the assistance and advice which can be obtained from officers who are given opportunities of studying those aspects of problems which are usually not accessible to local provincial officers is fully realised. The Forest Department, in this respect, appears to have realised from actual experience the importance of (1) freedom for the development of local initiative, and (2) mutual good-will, which renders possible loyal co-operation and co-ordination of work for the common good—principles which, after all, constitute the foundation of the British Empire itself.

In a recent publication issued by the Government of India it is noted that the Indian forest estate constitutes a "huge mine of wealth, the fringe of which has been barely touched," and whether regarded from the commercial or the scientific point of view the magnitude and many-sided interest of the work which lies before the officers of the Indian Forest Department to-day can scarcely be surpassed. Finally, the forest officer in India who is brought into intimate contact with men of all degrees, ranging from the aboriginal tribes of remote forest tracts to captains of industry and scientific experts, has it in his power to do much to promote the good-will and co-operation between men of different classes, occupations, races, and creeds which are so important to-day for the welfare of the British Empire and, indeed, of civilisation itself.

The Investigation of Gravity at Sea.

By PROF. W. G. DUFFIELD.

THE most notable attempt to measure the variation of the force of gravity over the surface of the oceans was that made by Hecker in the early years of the present century; in 1901 he surveyed a track across the Atlantic from Lisbon to Bahia, following this up a few years later with the investigation of the Indian and Pacific Oceans and the Black Sea.

Helmert had developed a formula for the variation of gravity with latitude from observations collected from a large number of land stations, and the immediate object of Hecker's investigation was to test its application to determinations made over great ocean depths. The problem of an oceanographic gravity survey has long fascinated geophysicists, because observations on board ship are practically made from the surface of the geoid, and should lead to the determination of the shape of that much-discussed figure; and what is also of importance, its solution should likewise lead to a knowledge of the extent to which isostatic compensation is complete over otherwise inaccessible parts of the globe.

Since observations of gravity must be made with great accuracy if they are to be of any value for such purposes, the examination of the gravitational acceleration at sea is attended by great difficulties; on a moving ship, rolling and pitching produce vertical accelerations which are individually indistinguishable from deviations from the true value of g. Reliance must therefore be placed upon suitable damping devices which will reduce the effect upon the instruments of such extraneous accelerations, or at least enable their mean value to be determined within narrow limits of error.

Hecker's original method depended upon the simultaneous measurement of the atmospheric pressure by means of a mercury barometer and a boiling-point apparatus; the latter determination is independent of the local value of gravity, and, if equated to ρgh for the mercury column, gives the necessary information for the evaluation of g. A fine constriction in the barometer tube provided a heavy damping factor which reduced the amplitude of the oscillations of the mercury surface; some of Hecker's instruments recorded photographically upon a moving film and provided a trace from which the normal level of the mercury might under favourable conditions be gauged.

Hecker considered that his observations showed that Helmert's formula held good within, roughly, one part in 30,000 for both deep and shallow seas, indicating a high degree of isostatic compensation; his conclusions have, however, been subject to a good deal of unfavourable criticism both on this and on the other side of the Atlantic, and it is true that disappointing inconsistencies appear in successive boiling-point determinations and in the simultaneous readings of the four barometers, which possessed different amounts of "lag," and that in certain other respects objections may be urged which prevent us from accepting the verdict on the evidence placed before us; nevertheless, it was pioneering work, and the difficulties to be encountered were largely unknown, and certainly untried, when the investigation was begun. Whether Hecker's conclusion be confirmed or refuted, those who follow will not fail to benefit by his early experiences.

With a view to a further oceanographic gravity survey, Hecker constructed apparatus based upon a different principle, one which had been unsuccessfully tested at sea by William Siemens in 1859. This time he used a barometer with a sealed cistern, so that the column of mercury should be supported by the pressure of the contained air; the cistern was immersed in a vacuum flask packed with cork shavings to keep the temperature, and therefore the pressure of the air, as steady as possible. Hecker arranged that four of these instruments should be mounted at the corners of a rectangular box containing apparatus for the photographic registration of the heights of the mercury columns. The box was mounted upon central gimbals, designed to maintain the barometers vertical as the ship rolled or pitched. It is clear that if the pressure within the cistern is known from temperature observations, the value of g is obtainable.

Lecturing in July, 1913, Prof. A. E. H. Love suggested that the voyage of the British Association to Australia in the following year might afford a valuable opportunity for once more testing the value of gravity at sea, and urged upon British astronomers and physicists the importance of the problem. His appeal proved irresistible. The time for preparation for so great an undertaking was very short; nevertheless, it was found possible, largely through the generous provision of instruments by the Meteorological Office and the Cambridge Scientific Instrument Co., to accumulate apparatus whereby tests could be carried out by three separate methods. Profs. Hecker and Helmert were anxious to have the instrument already described tested at sea, and willingly offered it for trial during the voyage; it was, therefore, brought from Strassburg in June, 1914, and installed on s.s. *Ascanius* in Liverpool.

Of the other pieces of apparatus one depended upon much the same principle as that of Siemens and Hecker—namely, the equilibrium of a column of mercury supported by air pressure within a closed vessel—but there were important differences; it was arranged that the lower surface of the mercury should always be brought to the same level in the cistern, an adjustment determined by an electric contact with a point which completed a telephone buzzer circuit. This ensured a constant volume for the enclosed air. The height of the barometer column was not directly observed, but estimated by measuring the length of the thread of mercury, which it was necessary to introduce into the apparatus through a fine capillary tube in order to secure contact at the lower surface. Assuming that the temperature remained constant, a defect in gravity would demand the addition of mercury in order to lengthen the barometer column sufficiently to balance the pressure of the air in the reservoir. The sensitivity could be made great by adopting a high ratio between the cross-section of the barometer tube and that of the capillary index tube through which the mercury was introduced.

A valuable suggestion for the improvement of this apparatus came from Sir Horace Darwin, who pointed out that the bulk of the difficulty occasioned by fluctuations of temperature might be overcome by employing such a volume of mercury within the apparatus that its expansion would automatically provide the additional height of mercury in the barometer tube necessary to balance the increase of pressure of the air in the reservoir due to a rise in temperature.

The third method consisted in comparing the readings of a mercury barometer with those of an aneroid; both were open to the atmosphere, and, as in the boiling-point method, we have the equation $\Pi = \rho g h$ to give us the variations of g, Π being now given by the aneroid, and h and ρ by the barometer and its attached thermometer. The aneroid was specially constructed and kindly lent by Sir Horace Darwin for this research. On board a ship the voyage of which carries it through many degrees of latitude one of the greatest difficulties is to obviate the effects of large changes of temperature. On the outward voyage this difficulty was very largely overcome by the generous installation by Messrs. Alfred Holt and Sons of a special refrigerating chamber on s.s. *Ascanius*, which served as an excellent laboratory. It was furnished with a separate system of brine pipes, and though at first there were rather large fluctuations, two engineers on day and night duty eventually became so adept at regulating the flow of brine that during the latter stages of the voyage the variation amounted to considerably less than one degree over a period of twenty-four hours, even though the observer was frequently within the chamber for an hour or more at a time. In future work it should, if possible, be arranged that it is not necessary for the experimenter to remain in the chamber for lengthy periods, as it is detrimental to health; but the experience does suggest that it is possible to overcome the very serious difficulty of maintaining a large room at an approximately steady temperature throughout the voyage.

Unfortunately, the outbreak of war at the time the British Association reached the shores of Australia led to the ship being commandeered for troops, so it was not possible to make use of this laboratory on the return voyage, and a good deal of the experience gained was wasted. A place was, however, found in the refrigerating chamber of the P. & O. R.M.S. *Morea* for all the apparatus, so the test was continued, though under very unfavourable conditions on the homeward journey.

It had scarcely been hoped, when the expedition was planned, to do more than obtain experience and information which would serve as a guide for future work upon gravity at sea, and more than this is not claimed for the results. Briefly, it may be stated that leaks which developed in Hecker's apparatus, and a troublesome temperature gradient between the cistern and the stem of the barometers, demand radical alterations in its design if it is to be rendered efficient. For the brief period of the voyage when the gravity barometer could be favourably observed, results were obtained which seemed to indicate that the method was one of promise, and it may be of interest to state that new apparatus of this type is in course of construction; the design has been modified in the light of experience gained at sea, and of a mathematical examination of the instrument by Sir Arthur Schuster. One specially favourable feature of the instrument is the possibility of completely immersing it in a constant-temperature bath.

Though the particular aneroid "pumped" with the motion of the ship more than was hoped, and had a reduction factor and zero which changed slightly during the voyage, the aneroid method is one which should be further examined, and certain directions in which alterations in the design are desirable were indicated by the experience on the voyage to Australia. With it the general variation of gravity with latitude over the ocean is readily shown, but whether it may be trusted to discriminate between such variations as may be found over deep and shallow waters must be a matter for further examination. We may note, as a matter of interest, that such indications as were obtained with this method suggested a defect of gravity over great ocean depths, along continental seaboards (especially when there was a coastal range of mountains), and an excess of gravity at island stations; but, as we have stated, a more rigorous test with improved apparatus is necessary before this can be accepted. The problem has therefore arrived at an interesting stage; Hecker's observations are in favour of nearly full compensation, whereas the slight evidence of the later work, so far as it goes, suggests that compensation is incomplete.

Reference has already been made to the instrument constructed in 1859 by William Siemens—in that year he was carried in a warship across the Bay of Biscay, his real object being the determination of ocean depths, which he took for granted would be shown by a diminished value of *g*. Dissatisfied with his first apparatus, he did not make a further attempt until 1875, when he constructed an instrument which depended upon balancing the pressure of a column of mercury against the tension of a spring, and this he tested on a cable-laying ship over a portion of the voyage between the Thames and Nova Scotia. The results, in spite of anomalies as regards latitude variation, which puzzled Siemens, show a surprising measure of agreement between predicted and observed depths, which, so far as they go, are in accord with the aneroid observations just referred to. This must not, however, be overemphasised, since Siemens was dissatisfied with this apparatus. Though not really directed at the solution of the problem under discussion—Siemens's "bathometers" were graduated in fathoms—these instruments are of interest in that they appear to have been the first involving gravity measurements to be submitted to an actual test at sea.

Since the Australian meeting of the British Association in 1914, further work has been carried out under the auspices of an influential committee of that body, and certain other points have received attention. From a series of experiments carried out last year on H.M.S. *Plucky*, it appears that the ship's motion through the air may very appreciably affect the pressure recorded by an open barometer, even when carried in cabins below deck; hence, as the "lag" of this instrument is in general different from that of the instrument with which it is being compared, it is very undesirable to adopt barometers of the open type for gravity determinations. On board the destroyer effects as large as one millibar were found to be due to the relative motion of the ship and the air; no doubt a similar disturbing influence affects the readings of a barometer in a building about which a wind is blowing.

Another matter which was examined on H.M.S. *Plucky* was the Eötvös effect; going east with the earth, the centripetal force is greater than when steaming west; consequently a correction for motion in longitude is indicated. After eliminating windage effects, a change equivalent to 0·1 mb. was observed when the course was altered from E. to W. when steaming at 22 knots.

There are other points the investigation of which is not yet complete: the best diameter of capillary tubing to be used in the barometer tube to damp down the effects of the ship's vertical motion, the influence of the throbbing of the ship's engines upon the barometer reading—there is some suspicion that certain divergences between gravity readings in harbour and in the open sea may be accounted for by the change in capillary forces due to this cause—the best form of constant-temperature chamber for use at sea, steady to 1/100 degree: these and allied questions are engaging the attention of those who are contemplating a fresh attack upon the problem.

Obituary.

Prof. H. A. Bumstead.

THE death of Prof. H. A. Bumstead, professor of physics in Yale University, which occurred with tragic suddenness on January 1 when he was travelling from Chicago to Washington, will be felt with the keenest regret by a large number of men of science in this country. There are few American men of science with more English friends than had Prof. Bumstead, and none whose friendship and companionship were more highly prized. Born in 1870, he graduated at Johns Hopkins in 1891. He began in 1893, as instructor in physics in Sheffield Science School, that connection with Yale which continued without interruption until his death, where, for fourteen years, he had been professor of physics and director of the Sloane Physical Laboratory. Prof. Bumstead was the most enthusiastic and devoted of Yale men. He came over to Cambridge in 1904, and worked for a year at the Cavendish Laboratory; the result of his work is contained in a paper in the *Philosophical Magazine* for June, 1906, p. 292, on the heating effects produced by Röntgen rays in different metals. On his return to America he made, in spite of serious ill-health, important researches on the properties of α-rays.

Excellent as Prof. Bumstead's published work is, it gives but an inadequate idea of his powers, or of his singularly clear and sane judgment. He edited the collected works of Willard Gibbs—the greatest physicist ever associated with Yale. When America joined in the war, he threw all his energies into the application of science to the purposes of the war, and at the end of 1917 he came over to this country as Scientific Attaché to the American Embassy. Prof. Bumstead's duties were to co-ordinate the scientific work done in America and in England and France, so that the results obtained in one country should be as soon as possible at the services of the others. For this work his personal qualities and scientific attainments made him especially fitted, and he did most valuable work whilst he was in this country. He was at the time of his death president of the National Research Council in the United States.

Prof. Bumstead had a singularly attractive and charming personality. Sympathetic, modest, without a trace of self-assertion, he was the most delightful companion and most valued friend.

J. J. T.

PRINCE P. A. KROPOTKIN.

THE death of Prince P. A. Kropotkin at Dmitrov, near Moscow, on Friday last, January 28, deprives the world of a picturesque figure and science of a devoted student. For many years Prince Kropotkin was an esteemed contributor to the columns of NATURE, and when he left England to return to Russia in 1917 he wrote to express regret that the very close relationships which had existed between him and us for so long were being severed. He said at the same time that he had been a reader of NATURE from the first number, and had even been permitted to receive it while a prisoner in the fortress of St. Peter and St. Paul in St. Petersburg.

Prince Kropotkin was born on December 9, 1842. At the age of fifteen he entered the select military school at St. Petersburg; on leaving he joined a Cossack regiment stationed on the Amur, and while aide-de-camp to the commander of the General Staff in Eastern Siberia, he crossed North Manchuria from Transbaikalia to the Amur and up the Sungari to Kirin, travelling in all as many as 50,000 miles. In 1867 he abandoned a military career, and returned to St. Petersburg, where he entered the University, and devoted himself seriously to geographical work. He then became closely associated with political movements, and gave himself up to propaganda. In 1873 he was arrested and imprisoned, but escaped in the following year and made his way to England, shortly afterwards going to Switzerland. After the assassination of Alexander II., Kropotkin was expelled from Switzerland, and settled in Savoy, where he was arrested in 1883 on a charge of organising a dynamite outrage, and was condemned to five years' imprisonment, but was released in 1886. He then returned to England, and remained here until June, 1917.

In 1876 Kropotkin published his "Researches on the Glacial Period," in which he described a journey in Finland and a short visit to Sweden, both made in 1871, under the auspices of the Russian Geographical Society, for the special purpose of studying the glacial formations and the eskers. His conclusions were that this low tableland was once covered by an immense ice-sheet, which, creeping from Scandinavia, crossed the Gulf of Bothnia and traversed southern Finland in a direction south by east, leaving behind it the marks of its course in the shape of numberless striæ and moraines.

Perhaps Kropotkin's most notable work was "Mutual Aid, a Factor in Evolution," published in 1902. The view put forward was that in the case of animals there is very little evidence of any struggle for existence among members of the same species, though plants, beyond all doubt, jostle their own kin out of existence. Animals, as a rule, are banded together for mutual protection, and those that have the best organisation for mutual defence are those that thrive best. Among men, mutual aid is more general than among animals; among savages, it is the chief factor in evolution. Kropotkin traced the growth of the modern benefit societies, co-operative associations, and trade unions back through successive stages of the history of a nation—through the State, the medieval city with its fortifications and hired defenders, the village communities, and finally to the clan, showing how man has attained his present position chiefly by practising mutual aid. There is no doubt that in the development of this thesis Kropotkin was keenly interested, and that the work itself represents, more closely than anything else he did, the main trend of his conception of the meaning of life and progress.

Kropotkin was a pioneer advocate of the intensive cultivation of crops, and in a suggestive little book entitled "Fields, Factories, and Workshops" he described what was done in this direction in Guernsey, as well as indicated how similar principles of culture could be applied elsewhere. His view was "that 600 persons could easily live on a square mile, and that with cultural methods already used on a large scale 1000 human beings —not idlers—living on 1000 acres could easily, without any kind of overwork, obtain from that area a luxurious vegetable and animal food, as well as the flax, wool, silk, and hides necessary for their clothing."

These two latter works reveal Kropotkin's unbounded faith in man and his hope for a high human destiny through the reconstruction of society and communal production. His knowledge extended over a wide scientific field, and his interest in its advancement never failed. His many friends in this country will long cherish his memory with affection and esteem.

The death occurred, on January 18, of Mr. Rupert Farrant, at the age of thirty-six years. Mr. Farrant was educated at the Westminster Hospital, and he studied also at King's College and St. Bartholomew's Hospitals; after he had qualified as a practitioner in 1906, he held many resident posts in various London hospitals. In 1909 he was made a fellow of the Royal College of Surgeons, and on two occasions he delivered Hunterian lectures at the college. Mr. Farrant made a special study of the ductless glands, especially of the thyroid, in connection with the general metabolism of the body, and he put forward a theory of a correlated cycle of changes in the histological appearance and functional activity of the gland under the influence of toxins. He saw active service at Gallipoli, in Egypt, in Mesopotamia, and in France, where he received injuries by a shell explosion, from the concussion of which he never completely recovered.

It is with deep regret that we learn of the sudden death, on January 31, in his fiftieth year, of Dr. J. C. Cain, editor of the Chemical Society's publications since 1906, and author of leading works on synthetic dyestuffs and intermediate products.

We much regret to announce the death, on January 30, at sixty-five years of age, of Mr. C. E. Fagan, secretary of the British Museum (Natural History), to whose expected retirement after a long period of devoted service reference was made in our Notes columns on January 13, p. 638.

Notes.

The gold medal of the Royal Astronomical Society has been awarded by the council to Prof. H. N. Russell for his contributions to the study of stellar evolution. It will be presented to Prof. Russell at the annual general meeting to be held on Friday, February 11, when the president of the society, Prof. A. Fowler, will deliver an address on the notable work for which the award has been made.

The Lords Commissioners of the Treasury have appointed Sir Robert Robertson, K.B.E., F.R.S., Director of Explosives Branch, Research Department, Woolwich, to be Government Chemist in succession to Sir J. J. Dobbie, who has retired.

A memorial lecture on the life and work of the late Sir William Abney is to be delivered to the Royal Photographic Society of Great Britain by Mr. Chapman Jones. April 26 next has been provisionally fixed for the date.

The council of the Chemical Society has arranged to hold the anniversary dinner at the Hotel Cecil on Thursday, March 17 (the day of the annual general meeting), at 7 for 7.30 p.m., and to invite, as guests of honour, the past-presidents who have attained their jubilee as fellows of the society.

Dr. W. R. G. Atkins, of Trinity College, Dublin, has been appointed head of the department of general physiology at the Plymouth Laboratory of the Marine Biological Association.

Sir Norman Moore, president of the Royal College of Physicians, has appointed Dr. Herbert Spencer to deliver the Harveian oration on St. Luke's Day (October 18), and Dr. Michael Grabham, of Madeira, to deliver the Bradshaw lecture in November. The council has appointed Dr. Major Greenwood to deliver the Milroy lectures in 1922.

A discussion on gravity at sea will be held in the rooms of the Royal Astronomical Society, Burlington House, to-morrow, February 4, at 5 p.m. The chair will be taken by Sir Arthur Schuster. Prof. W. G. Duffield will open the discussion, which will be continued by Sir S. G. Burrard, Dr. H. Jeffreys, Dr. J. W. Evans, and Dr. A. Morley Davies.

A special joint meeting of the Society of Chemical Industry and of the Institution of Mechanical Engineers will be held at the rooms of the institution, Storey's Gate, Westminster, S.W.1, on Friday, March 4, at 6 p.m., when M. Paul Kestner, president of the Société de Chimie Industrielle, will read a paper on "The De-gassing and Purification of Boiler Feed-water."

At the meeting of the London Mathematical Society to be held in the rooms of the Royal Astronomical Society at Burlington House, W.1, on Thursday, February 10, at 5 p.m., Prof. A. S. Eddington will deliver a lecture on "World Geometry." The lecture will be concerned with the mathematical side of the general theory of relativity, with especial reference to electricity and gravitation and the work of Prof. H. Weyl. Visitors from other societies will be welcome.

In the issue of Nature for January 27 there appeared an illustration (p. 699, Fig. 2) of a sculptured group from the decoration of the building of the Institute of Human Palæontology in Paris. The official description which was supplied with the photograph stated, no doubt by inadvertence, that the anthropoid forming part of the group was an orang-utan. A close inspection, however, shows that it is undoubtedly a gorilla.

Science of January 14 announces that the Rockefeller Foundation has given to France complete control over the elaborate anti-tuberculosis organisation established in the Department of Eure-et-Loir at a cost of 4,000,000 francs. The organisation consists of twenty-four dispensaries, four complete isolation services, and a departmental sanatorium and laboratory. The system will serve as a model for similar organisations to be established by the Government throughout the country. The Rockefeller Foundation is now assisting in the anti-tuberculosis campaign in thirty-eight of the eighty-seven Departments of France, and work is contemplated which will last for another two years.

At the annual general meeting of the Royal Meteorological Society on January 19 the following were elected officers and members of council:—*President:* Mr. R. H. Hooker. *Vice-Presidents:* Mr. J. Baxendell, Mr. W. W. Bryant, Sir Napier Shaw, and Dr. E. M. Wedderburn. *Treasurer:* Mr. W. V. Graham. *Secretaries:* Mr. J. S. Dines, Mr. L. F. Richardson, and Mr. G. Thomson. *Foreign Secretary:* Mr. R. G. K. Lempfert. *Councillors:* Mr. C. E. P. Brooks, Capt. C. J. P. Cave, Mr. J. E. Clark, Mr. R. Corless, Dr. H. N. Dickson, Mr. G. M. B. Dobson, Mr. F. Druce, Mr. J. Fairgrieve, Mr. H. Mellish, Mr. M. de C. S. Salter, Dr. G. C. Simpson, and Mr. F. J. W. Whipple.

The Minister of Health, with the concurrence of the University Grants Committee, has appointed a Committee "to investigate the needs of medical practitioners and other graduates for further education in medicine in London, and to submit proposals for a practicable scheme for meeting them." The members of the Committee are as follows:—The Earl of Athlone (chairman), Mr. H. J. Cardale, Sir Wilmot Herringham, Sir George Makins, Sir George Newman, Sir Robert Newman, Sir Edward Penton, Sir E. Cooper Perry, Mr. J. Dill Russell, and Dr. T. W. Shore. Mr. A. L. Hetherington will act as secretary of the Committee, and all communications should be addressed to him at the Ministry of Health, Whitehall, London, S.W.1.

At a meeting of the award committee, consisting of the presidents of the principal representative British engineering institutions, held in London on Tuesday, January 25, the first triennial award of the Kelvin gold medal was made to Dr. W. C. Unwin, who was, in the opinion of the committee, after consideration of representations received from leading engineering bodies in all parts of the world, the most worthy to receive this recognition of pre-eminence in the branches of engineering with which Lord Kelvin's scientific work and researches were closely identified. The arrangements for the presentation of the medal will be announced shortly. The Kelvin gold medal was established in 1914 as part of a memorial to the late Lord Kelvin and in association with the window placed in Westminster Abbey in his memory by British and American engineers.

The members of Mr. L. H. Dudley Buxton's expedition have now returned from a stay of some weeks in the Island of Malta. The object of the expedition was to collect material for a study of the physical anthropology of this island. About 1000 adults, men and women, were measured. The fine series of ancient bones which Prof. Zammit excavated in the Hypogæum at Hal-Saflieni and elsewhere was collected together and measured. A long series of skeletal remains from a modern ossuary was also examined. A special visit, lasting for two days, was paid to Gozo by Mrs. Jenkinson and Miss Moss to work at the physical anthropology of that island. The expedition has collected an immense mass of valuable material, which will take some time to arrange and digest. As soon as this work is sufficiently far advanced Mr. Buxton hopes to submit a preliminary account of the results of the expedition to the Royal Anthropological Institute.

At an extraordinary general meeting of the Chemical Society held in May, 1919, for the purpose of dealing with various modifications of the by-laws, amongst which was the provision for the admission of women as fellows on the same terms as men, the council was authorised to apply to the Crown for a supplemental charter giving the power to make the necessary alterations in the by-laws. The petition for the supplemental charter received the assent of his Majesty the King, and all the additional powers sought by the society were thus secured. The new by-laws recommended by the council received the approval of the general body of fellows at an extraordinary general meeting held on April 29, 1920, and came into operation on June 1. At the ballot for the election of fellows held on December 2 last, of the ninety-seven who were elected fellows twenty-one were women, and amongst the candidates for whom a ballot will be held on February 17 appear the names of six women.

Reference was made last week to correspondence in the *Times* on the effects of the discharge of oil from ships into the sea. Oil enters the sea in various ways, *e.g.* the "steaming-out" of the "tankers" and accidental leakages. The "benzene" oils must evaporate quickly, but the heavy fuel-oils may be more persistent. So far the evil is local, and there is no evidence of any widespread effect upon the larger fisheries. Sir Arthur Shipley suggests, on the authority of Prof. A. Meek, that 1916–17–18 were bad years for plaice fry, and that some factor was in operation during that period which was detrimental to fish-life. This factor may have been the discharge of oil from sunken ships. On the other hand, there is strong statistical evidence that plaice were more abundant in the North Sea during the years 1919–20 than during the years immediately before the war. This is also the case in the Irish Sea, 1910 being a maximum, 1918 a minimum, while 1920 and 1921 tend towards another maximum. Prof. H. E. Armstrong refers to the failure of the Loch Fyne herring fishery, and suggests that this was due to "floating defilement from the Clyde," but the herrings are now returning to Loch Fyne. The question is a very complex one, and investigation is obviously called for. In connection with the subject discussed, Lord Rayleigh refers in the *Times* of January 27 to experiments made by his father in 1889, which showed that a continuous film of oil on the surface of water need not be so much as a ten-millionth part of an inch in thickness. "On the basis of his figures it may be calculated that the ocean could be covered by 500,000 tons of oil—not beyond the carrying power of a fleet of very large ships."

SIR ROBERT HADFIELD contributed recently an article to the *Iron and Coal Trades Review* on "The World Hunger for Steel." It appears that in 1913 the exports of steel from the three chief steel-producing countries were as follows:—Germany, 5,500,000 tons; Great Britain, 5,000,000 tons; and the United States of America, 2,750,000 tons. Against this the estimates of the exports in 1920 were as follows:—Germany, 200,000 tons; Great Britain, 3,300,000 tons; and the United States, 4,300,000 tons. The statistics of production reinforce the lesson given by the export figures. In 1913 the world's production in pig-iron amounted to about 76,000,000 tons; last year it is estimated to have been not more than 56,000,000 tons. Taking these figures as well-founded, it will be recognised readily that the world is very short of supplies of iron and steel. Sir Robert Hadfield points out that this shortage is a very serious matter, and that the development of modern civilisation must be greatly hindered unless increasing supplies can be obtained. He estimates the shortage of steel at from 25,000,000 tons to 30,000,000 tons. He then goes on to consider the question of costs of production, and points out how vital is the price of fuel. Two months ago it is estimated that the cost of coal at the pit's mouth in this country was 34*s.* a ton, whilst in America it was about half that figure. In both countries it takes about 1¾ tons of coal to produce 1 ton of iron. There are, however, countries where coal is produced more cheaply than in America, and Sir Robert states that in South Africa, India, and China it is being raised and sold at very little more than 5*s.* a ton. In spite of these considerable differences of price, he holds the view that there is no reason why there should not be a greatly increased production in this country owing to the demand caused by the shortage of steel, which has been emphasised. Whether this will prove to be the case depends principally upon the extent of co-operation between employers and employed.

FROM the *Brooklyn Museum Quarterly* for April, 1920, we learn that the expedition sent by that museum to make collections in the coastal waters of Peru has been most successful. Mr. R. C. Murphy, who was in charge of the expedition, reports large collections of marine animals and plants and geological specimens. A series of kinematograph pictures of wild life on the coast and of the Peruvian guano industry was also obtained. Special attention was paid to the investigation of the conditions of marine life dependent on the Humboldt current.

IN the *Museums Journal* for January Mr. E. N. Fallaize formulates a scheme for the classification of the subject-matter of anthropology, in which human structure and activities rank before divisions of time and space. The reasons for the arrangement are discussed, and the actual scheme will follow in the February issue. The Headmaster of Winchester gives sound advice on lantern-slides of Renaissance art; Prof. Aldred Barker, of Leeds, reviews a guide to carpet-knotting and weaving; and Mr. R. L. Hobson, of the British Museum, writes on Pountney's "Old Bristol Potteries." A technical criticism of the Wallace Collection from the museum curator's point of view, and other reviews and notes, make up an interesting number. Dr. Bather, who has taken charge of the journal for ten months, now hands over the editorship to Mr. J. Bailey, who is retiring from the Victoria and Albert Museum.

WE have recently received the July number (vol. ii., No. 3) of the *Queensland Naturalist*, which, owing to the difficulties of the past few years, has been in abeyance since April, 1917. It is the organ of the Queensland Field Naturalists' Club, and is described in the foreword of the present number as the only journal of its kind published in a State which is, from a natural history viewpoint, probably the richest field in the whole of Australia. The editor refers to the success of the club in initiating or aiding efforts for the better protection of the fauna and flora of the Macpherson and Bunya ranges, and of particular birds and animals. Among the short articles included in this number is a description of a new fossil plant from Petrie's Quarry, near Brisbane, and a critical account, by Mr. C. T. White, of two native phalloid fungi, one of which is endemic in South-Eastern Queensland.

THE myriopods, or more correctly the Diplopoda, of the sub-family Pyrgodesminæ, are small creatures from ¼ in. to ⅜ in. long, with the back curiously covered with processes or tubercles, and bearing also bristles or papillæ. These latter gather the dirt, and often so encrust the body as to mask its form and merge its colour in that of the ground, so, though they cannot really be rare, from the Orient we have hitherto known representatives of only two genera, the Pyrgodesmus and Lophodesmus of Pocock (1892). Now in the Records of the Indian Museum (vol. xix., part 4) Dr. F. Silvestri describes five new genera based on species from Cochin, Ceylon, and New Guinea. His Latin descriptions are illustrated by excellent drawings, which, in the absence of an artist's name, we must assign to the author's own pen. Some of these show the body *humo indutum*, others *humo denudatum*.

IN spite of war difficulties, Dr. Annandale, in his Report on the Zoological Survey of India for the years 1917–20, has been able to record an amount of work important in itself and remarkable as conducted by a scientific staff of four persons only. The purely zoological inquiries happened to deal with various aspects of river- and lake-life. Thus the return to India of troops infected with Schistosoma and the fears that the infection might spread led to an extensive search for possible molluscan hosts; the results, fortunately negative, saved the expenditure of large sums of money on needless precautions. Some interesting points of wider application crop up in some of these investigations. The resemblance of the fauna in a muddy creek of the Ganges to that of the deep sea is assigned by Dr. Kemp to the common factors of a muddy bottom and low visibility. The discovery that the peculiar sculpture of the shell in certain Viviparidæ is connected with the persistence of structures present on the edge of the mantle in the embryos of smooth-shelled forms bears on the origin of the varied ornament in those molluscs. These and many other interesting results have suggested to Dr. Annandale the need for a survey of the macroscopic fauna of the lakes of Asia.

At the request of Alderman F. C. Clayton, some members of the botanical department of Birmingham University visited the Birmingham Water Department's reservoirs at Shustoke, near Whitacre, on October 14 last. The water in the smaller of the two reservoirs (about 8 acres in extent) had been drained off at the end of July for cleaning purposes, leaving the bottom covered to a depth of 1½ ft. to 2½ ft. with a mixture of vegetation and mud. The small reservoir had not previously been cleaned, except at the sides, since its completion in 1883. The vegetation appeared to have consisted mainly of green algæ, together with a number of aquatic flowering plants and a marginal zone of *Fontinalis antipyretica*. The algæ were represented by a number of genera, *Cladophora fracta* being the dominant species. An allied species, probably a form of *C. crispata*, occurs regularly in the slow sand filter-beds at the neighbouring waterworks. During the cooler months this alga often covers the bottoms of the filter-beds with a matted felt of algal filaments, locally known as "blanket weed." So long as the alga remains on the bottom it appears to assist materially in the process of filtration. On the advent of hot weather the alga tends to rise, and has to be removed. Another feature of interest is the very rapid colonisation by plants of the drying, muddy bottom of the reservoir. Although only some two and a half months had elapsed since the lowering of the water-level, the surface of the mud was already occupied by an open association of plants which included algæ, together with patches of stunted land forms of aquatic flowering plants. In addition to the true aquatics, semi-aquatics, and even land plants, were spreading rapidly in a centrifugal direction over the surface.

On Friday, January 28, a general meeting of the Association of Economic Biologists, presided over by Sir David Prain, was held in the Imperial College of Science. Mr. E. E. Green showed a large Gasteropod which has been introduced into Ceylon, and is now present in destructive numbers. Dr. Llewellyn Lloyd gave an account of his investigations on the greenhouse white-fly and measures for its control, and described interesting new details in the structure and life-history of the insect. The only successful treatment is hydrocyanic fumigation, this being carried out at intervals of fourteen days in summer and of twenty-five days during the winter months. Light is a very important factor; the temperature should be between 40°–60°, and the dosage ¼ oz. of sodium cyanide to every 1000 cubic ft. space. Atmospheric humidity is relatively unimportant, but if cyanide-burning of the foliage is to be eliminated the plants should have dry roots. An animated discussion took place, in which Mr. Green, Prof. V. H. Blackman, Dr. Imms, Dr. Hargreaves, Mr. Dykes, and Mr. Emptage participated. Mr. Brierley then gave a paper on "Personal Impressions of some American Biologists and their Problems." Mr. Brierley was one of the three foreign representatives invited to the American Phytopathological Congress in 1920, and afterwards visited the principal scientific institutions and many regions of botanical or agricultural interest.

The system of colour notation introduced by Munsell in 1905 has been found of such practical value by the manufacturers of colours and of coloured goods in America that the U.S. Bureau of Standards has undertaken an examination of the system with a view to its improvement. An account of the work done by Messrs. Priest, Gibson, and McNicolas forms Technologic Paper No. 167 of the Bureau. Colours are specified by their hue, their purity or chroma, and their brightness, luminosity, or "value," and the Munsell atlas contains coloured cards of six different hues—grey, red, yellow, green, blue, and purple—each in different degrees of purity and luminosity. These cards have been examined by means of the spectrophotometer, and curves which show the amount of light reflected of each wave-length are given. From these it appears that the Munsell "values" are proportional to the square roots of the amounts of sunlight reflected, and the authors suggest that in future editions of the atlas the numbers indicating the luminosities should be proportional to the logarithms of the reflections. In order to secure this and other suggested improvements, the Optical Society of America and the Bureau are now consulting those interested in colours.

One of the largest steel-frame buildings which have been constructed by welding methods in Great Britain is illustrated in *Engineering* for January 14. This building constitutes the new workshops of Messrs. the Double Arc Electric Welders, Ltd., and is situated in Glasgow. The steelwork throughout was welded by the company on its system. The name of this firm is derived from the special flux with which it coats its welding electrodes. The flux is conducting, and it is claimed that an independent arc is formed between the flux and the work, as well as the arc between the electrode and the work; this gives the double arc. The building is 27 ft. wide and 50 ft. long; there are five roof principals carried on columns having welded-on bases. The roof principals are built of angles and channels, both of which members are welded to the webs of the columns. The secondary members of the trusses, together with purlins, etc., are all welded at the points of attachment. Even the steel door-frames are welded. Electric welding would appear to offer many points of advantage in the field of construction, and is obtaining a sound footing.

The latest catalogue (No. 409) of Mr. F. Edwards, 83 High Street, Marylebone, W.1, consists of particulars of nearly a thousand books, maps, engravings, and drawings relating to North America (United States and Canada). Many items will be of interest to readers of NATURE, *e.g.* a number of works on the Indian tribes of North America, Audubon's "The Birds of America," the very rare book by T. Morton entitled "New England Canaan, or New Canaan," and the silver ticket of Benjamin Franklin's membership of the Royal Society of Edinburgh. The catalogue will be sent free of charge by the publisher.

IN the Fauna of British India Series the further volumes which the editor, Sir Arthur E. Shipley, with the assistance of Dr. Guy A. K. Marshall and the sanction of the Secretary of State for India, has arranged for are: Butterflies (Lycænidæ and Hesperiidæ), Mr. N. D. Riley; The Ixodidæ and Argasidæ, Prof. G. H. F. Nuttall and Mr. C. Warburton; Leeches, Mr. W. A. Harding; The Diptera Brachycera, Mr. E. Brunetti; The Operculata, Mr. G. K. Gude; The Curculionidæ, Dr. G. A. K. Marshall; The Carabidæ, Mr. H. E. Andrewes; The Meloidæ, Mr. K. G. Blair; The Erotylidæ and Endomychidæ, Mr. G. J. Arrow; The Culicidæ, Capt. P. J. Barraud, Major S. R. Christophers, and Mr. F. W. Edwards; The Chrysomelidæ, Mr. S. Maulik; The Oligochætæ, Lt.-Col. J. Stephenson; The Scolytidæ and Platypodidæ, Lt.-Col. Winn Sampson, together with a revised edition of Mammalia by Mr. Martin A. C. Hinton and Mr. R. C. Wroughton, and of Birds (4 vols.) by Mr. E. C. Stuart Baker.

THE list of new books and new editions added to Lewis's Medical and Scientific Circulating Library during October to December, 1920, has reached us from Messrs. H. K. Lewis and Co., Ltd., 136 Gower Street, W.C.1. Although intended primarily for subscribers to the library, it should be of great service to all who wish to keep in touch with medical and scientific literature, being practically a complete catalogue of important books in English on medicine and science issued during the period named. It is carefully classified according to subjects, and will be sent gratis upon application.

MESSRS. L. OERTLING, LTD., Turnmill Street, London, E.C.1, ask us to announce that they are recommencing their service of attendance to balances in customers' own laboratories throughout the United Kingdom. This service was discontinued during the war owing to the extreme pressure of work in the firm's manufacturing departments and to the lack of mechanics possessing the necessary technical ability.

Our Astronomical Column.

PLANETS NOW VISIBLE.—In the second week of February all the bright planets will be visible to the naked eye. Venus, Mars, and Mercury will be in the western sky, while Jupiter and Saturn will appear in the eastern.

Mercury will be at greatest elongation on February 15, when it sets about $1\frac{3}{4}$ hours after the sun. Venus will set on February 13 at 9.40 p.m., and Mars at 8.32 p.m. On February 9 the crescent of the new moon will be in conjunction with Mercury, and with Mars on February 11. Venus will be a very conspicuous object, but Mars will appear unduly faint, owing to its great distance from the earth.

Jupiter rises on February 14 at 7.33 p.m. and on February 28 at 5.52 p.m., while Saturn rises about 40 minutes later. These objects are situated in the southern part of Leo, and will be in the same region as the moon on February 23.

THE DIAMETERS OF STARS.—*Popular Astronomy* for January states that the observations of the diameter of Betelgeux were made on December 13 by Mr. F. G. Pease and Dr. J. A. Anderson, the method being due to Prof. A. A. Michelson. The measured diameter is given as 0·047″.

Prof. H. N. Russell, before the result was known, published the following estimates of the angular diameters of the brighter red stars:—Betelgeux, 0·031″; Antares, 0·028″; Aldebaran, 0·024″; Arcturus, 0·019″; β Crucis, 0·026″; and β Gruis, 0·020″. All these are within the range of possible measurement. The angular diameters of the stars of types A, B, and F are very much smaller (Sirius being 0·007″), and there is little prospect of success with them.

It is of interest to note that the parallax of Arcturus has recently been redetermined at Yerkes Observatory by Messrs. O. J. Lee and G. van Biesbroeck (*Pop. Astr.*, January). The result, 0·095″±0·006″, is larger than previous values. Russell's angular diameter would imply a linear diameter of one-fifth astronomical unit, or twenty-two times that of the sun. The thwart velocity would be 24 astronomical units per annum, or 70 miles/sec.

MINOR PLANETS.—The remarkable body HZ was observed at Algiers, January 12·3, in R.A. 0h. 17·5m., N. decl. 26° 52′, mag. 13·8. The planet has now been under observation for $2\frac{1}{2}$ months, and the orbit already published in this column, with perihelion near Mars and aphelion near Saturn, is fully confirmed. Such an orbit is obviously of a cometary character, yet careful scrutiny has failed to show any sign of nebulosity.

Nine hundred and thirty-three minor planets have now received permanent numbers. The difficulty of keeping such a large number under regular observation is considerable, so it is satisfactory to note that tables giving the approximate perturbations by Jupiter of about 100 planets have lately been published in *Astr. Nachr.*, which should be of great assistance in preparing accurate ephemerides. One planet in particular, 170 Maria, has been studied in great detail by K. Boda (*Astr. Nachr.*, 5080). This belongs to the Hestia type (period about $\frac{1}{3}$ of Jupiter's), and has small eccentricity, but considerable inclination. The tables are compared with observations from 1877 to 1916. The largest residuals (Obs.—Tab.) are + 58″ in 1889 and − 50″ in 1904. Greater accuracy could not be attained without very elaborate tables.

The chief centres of minor planet observation during the past year have been Algiers (MM. Gonnessiat and Jekhowsky), Barcelona (Prof. Comas Sola), Heidelberg (Dr. Max Wolf), and Hamburg. Marseilles observatory has assisted by circulating observations and ephemerides.

The London School of Tropical Medicine.

THE London School of Tropical Medicine, which in its new domicile in the Hospital for Tropical Diseases in Endsleigh Gardens, Euston Road, London, recently, under Royal auspices, commemorated its nativity, came into being twenty-one years ago.

The idea of a school emanated from Sir Patrick Manson, who at the time was Medical Adviser to the Colonial Office; it was at once grasped by his far-seeing official chief, the late Right Hon. Joseph Chamberlain; and it was aptly embodied forthwith in the benign fabric of the Seamen's Hospital Society, the solicitude of which for the brotherhood of the sea includes all the tropics in its range.

FIG. 1.—The museum, London School of Tropical Medicine.

Not only did the society accept the idea, it also magnanimously advanced the funds needed for its realisation, and in October, 1899, the young school was actually established, under the ægis of Sir Patrick Manson, as an adjunct to the society's branch hospital at the Albert Dock.

The school was, above all, designed to give practical training in the fundamental laboratory methods of investigating disease while keeping the laboratory in touch with the wards of the hospital, and collating the lessons of laboratory and clinic in set lectures by specialists versed in the medical and sanitary problems of the tropics, the ultimate object being not merely to teach a class how the prevalent diseases of tropical countries are recognised and treated, but also to train the individual man for the experimental investigation of disease in the course of his own career and field of opportunity abroad. It was, moreover, recognised as a vital necessity that members of the teaching staff should go afield from time to time in order to keep in touch with tropical diseases in their endemic areas.

In the early days of the school the main laboratory course was, perforce, conducted by a single whole-time teacher; but as—thanks to the powerful advocacy of Mr. Joseph Chamberlain—the financial position improved, additional whole-time teachers were appointed, a helminthologist and a protozoologist in 1905 and a medical entomologist in 1907, and so gradually the laboratory teaching became both fuller and more intensive.

Thus prior to the war the school in its sequestered situation at the docks had assumed its present stature, if not its present finish. It had been affiliated to London University; the practical worth of its curriculum was held in world-wide regard by the medical profession; its bead-roll included the names of nearly two thousand students drawn from every medical vocation and medical service in the tropical Dominions, as well as from many foreign countries; it had undertaken fifteen oversea expeditions for the study of specific pathological problems; and it was steadily countenanced by annual grants from official sources. That at this stage the school had also acquired public esteem outside official and professional circles may be inferred from the benefactions for the advancement of knowledge that were entrusted to its administration. In 1909 a scholarship of the annual value of 50*l.* was founded by Lord and Lady Sheffield; in 1912 a munificent bequest of 10,000*l.* by Lord Wandsworth was allotted by Sir William Bennett for the institution of a scholarship; and in the same year a sum of 70,000*l.* was collected for general purposes by Mr. Austen Chamberlain as a filial tribute to the memory of the founder.

FIG. 2.—A portion of the class laboratory, London School of Tropical Medicine.

The war, which revealed so clearly to this island its dumb dependence on the unconquerable soul of the merchant seaman, brought at its close to the Seamen's Hospital Society a practical expression of gratitude and admiration so full as to reflect some of its splendour on the society's Tropical School. As a tribute to the dauntless spirit maintained during the war by the merchant seaman, the British Red Cross Society and the Society of St. John together gave to the Seamen's Hospital Society the sum of 100,000*l.* for the purchase of the large building in Endsleigh Gardens which had been used in war-time as an officers' hospital, and for its endowment as a hospital in the first instance for sailors and soldiers who had contracted tropical diseases on service, and ultimately for the sailors in perpetuity. Room in this new Hospital for Tropical Diseases being available, the society decided that the kindred school should be included in the project. This decision was applauded by the school's sponsors at the Colonial Office, and by the stimulating influence of Lord Milner it attracted the necessary financial co-operation of a liberal and appreciative section of the public. Early in the year 1920, therefore, the school was translated from the remote, uncouth neighbourhood of the docks to an accessible London quarter strong in academic associations.

Re-established under such favourable auspices in a central position, the school now prosecutes its original design in all its fullness with an ampler staff and equipment. The well-avouched scheme of a main laboratory course, supplemented by clinical demonstrations and a system of lectures, is unchanged, as it both meets the wants of the man who already has some knowledge of tropical conditions and inspires the man to whom tropical responsibilities are prospective. The clinical instruction, moreover, which appeals so strongly to the practitioner coming home for a season for professional rejuvenation, is improved by the institution of a special clinical laboratory attached directly to the hospital and administered by its staff.

It is, however, to the advanced student—to the inquirer whose interests are not entirely engrossed in medical practice and who appreciates the unlimited opportunities for research that the tropics afford—that the recent developments of the school are more particularly adapted. The departments of protozoology, medical entomology, and helminthology have been reconstituted as distinct units, leaving the original nucleus of tropical pathology as a fourth independent unit. Each unit has its own director, assistant, and subordinate staff, and is equipped to accommodate the individual student who contemplates pursuing some special line of study abroad, or desires to work out particular material collected abroad, or has some set object of his own outside any participation in the general laboratory course in which all the departments co-operate as before. By this arrangement, which also permits a director or an assistant alternatively to go abroad without disturbance of the home routine, research in tropical medicine is doubly seconded. The advanced or special student will also benefit by the proximity of the Tropical Diseases Bureau, which is now housed with the school, and is about to permit a considerable part of its books and serials to be incorporated, as a permanent loan, in a common library.

The changes thus briefly outlined, however, illustrate that inexorable concatenation of pain with pleasure which supplied one of the texts of Socrates' valedictory discourse; for much as the school has gained by its removal, it has lost—for the present, whatever recompense may lie in the womb of Time—the mess and all the concurrent social amenities which graced its old home in the wilderness.

New Experiments on the Inheritance of Somatogenic Modifications.

By Prof. Arthur Dendy, F.R.S.

IT has long been suspected that the problem of the transmission from parent to offspring of somatogenic modifications ("acquired characters") might be solved more readily by physiological experiments directly involving the complex metabolism of the body than by crude surgical operations such as the amputation of limbs. This suspicion has been justified in a remarkable manner by the work of Messrs. M. F. Guyer and E. A. Smith, recently published in the *Journal of Experimental Zoology* under the general title "Studies on Cytolysins."[1] The physiologists, through their brilliant investigations of serum reactions, have placed a whole armoury of new weapons in the hands of the zoologist, and have even furnished him with a chemical means of determining the degree of relationship, and consequently the correct systematic position, of different "species" of animals. We now have to thank them for giving us a new means of approach to what is perhaps the most difficult problem in biological science.

It has been known for some time that the injection of foreign proteids into the blood of a vertebrate animal calls forth a most profound physiological response, and Messrs. Guyer and Smith have taken full advantage of this knowledge in devising their experiments. Bordet showed a quarter of a century ago that when the red corpuscles of the rabbit are repeatedly injected into the blood of the guinea-pig the latter acquires the power of destroying them, and serum prepared from these "sensitised" guinea-pigs will rapidly dissolve the red corpuscles of the rabbit *in vitro*, while the serum of untreated guinea-pigs has little or no effect. This experiment formed the commencement of our knowledge of a whole class of substances known as "cytolysins," which appear in the blood as the appropriate "antibodies" in response to the injection of such substances as red corpuscles, leucocytes, nervous tissue, spermatozoa, and crystalline lens, all of which, "when injected into the blood of an unrelated species, will form lytic substances more or less specific for the antigen used in the sensitising process," the antigens being presumably the characteristic proteids of the substances injected.

The "antibody" or "antitoxin" may be produced in large excess of the amount actually required to destroy the injected foreign proteid, and a highly sensitised serum may thus be obtained. It was with such a serum, sensitised to the crystalline lens of the rabbit, that Messrs. Guyer and Smith conducted their experiments. The serum was prepared by grinding up rabbits' lenses with normal salt solution and injecting the fluid into fowls. A "lens-sensitised" serum was thus obtained, *i.e.* a serum which would dissolve the lens-substance of the rabbit.

When this lens-sensitised serum is injected into the veins of a pregnant rabbit the young exhibit a tendency to develop defective eyes—especially as regards the lens, which may be more or less opaque or liquefied. The eyes of the parent are not affected, possibly because in the adult eye the blood-supply to the lens is so meagre that the sensitised serum cannot reach it, or the adult lens may be too tough to be affected by minute quantities of the lysin. The lens of the developing embryo, however, is a very

[1] "Some Prenatal Effects of Lens Antibodie" (*Journ. Exp. Zool.*, vol. xxvi., May, 1918); "Transmission of Induced Eye Defects" (*op. cit.*, vol. xxxi., August, 1920).

delicate structure with an abundant blood-supply, and no doubt the lysin reaches it through the maternal and fœtal circulation.

So far, of course, there is no question of any transmission of somatogenic modifications, or "inheritance of acquired characters." The authors have shown, however, that when the young rabbits with defective eyes in their turn produce offspring the defect is inherited. Moreover, it does not gradually diminish and finally disappear in succeeding generations, like the curious somatogenic modification of the shell investigated by Agar in Simocephalus, but actually tends to increase from generation to generation, until the whole eye may almost disappear. The transmission has now been observed through six generations, and—what is still more important as showing that we are dealing with a true case of the "inheritance of acquired characters"—the defect may be transmitted through the male parent only, thus precluding the possibility that it may be due to the action of the maternal blood upon the offspring *in utero*.

How the germ-cells are affected by the lens lysin is, of course, entirely unknown, and Messrs. Guyer and Smith are commendably cautious with regard to theoretical considerations. It would seem, however, that we have here as clear-cut a case of the inheritance of somatogenic characters as we are ever likely to obtain, and one which may be expected to throw much light on the problem of heredity in general.

The Planet Mars.

MR. G. H. HAMILTON (Lowell Observatory Bulletin, No. 82) gives a detailed account, with many drawings, of his observations of the planet Mars at Flagstaff during the apparition of 1918. His observations closely corroborate those of Lowell. He notes that the dark band round the polar cap appears only when the cap is melting; when it is forming, its edges are indistinct. This difference is opposed to the merely optical character of the dark band upheld by some authorities. He also saw a large lake travelling away from the polar cap until it joined the Lucus Hyperboreas. It behaved like surface-water resulting from the melting cap. Mr. Hamilton also claims to have seen the same seasonal development of the canals, proceeding equatorwards, that Lowell described. He notes that the seeing depends on the Martian atmosphere as well as on our own; the details were sometimes blurred and dim, with excellent local seeing.

Conferenze e Prolusioni for December last contains a lecture on Mars by Prof. Pio L. Emanuelli, of the Vatican Observatory. Prof. Emanuelli denies the existence of the geometrical canals, pinning his faith to the results of the largest telescopes. He quotes an interesting observation by Prof. Hale made with the 60-in. reflector at Mount Wilson in 1909. The seeing was very good, permitting the use of a power of 800; the structure of the surface appeared exceedingly complex, far more so than could be shown in a sketch; the dark areas were covered with fine details, not, however, arranged in geometrical patterns. The two canals from the Sinus Sabæus were seen as broad stripes, resolved into minute detail like interrupted and twisted filaments. Prof. Emanuelli quotes similar results from the Yerkes Observatory, and those made in 1909 by M. Antoniadi with the 30-in. refractor at Meudon. He makes, however, no allusion to the necessity of prolonged observation, at various seasons of the Martian year, required to gain an insight into the nature of the processes going on on the planet's surface.

The Journal of the Astronomical Society of India (vol. x., Nos. 7, 8, and 9) contains an article on Mars by Dr. D. N. Mallik, who confines himself, however, to the single question of the Martian origin of the stray wireless signals, concerning which there was considerable discussion in the daily Press last year. Dr. Mallik has no difficulty in establishing the utter improbability of such an origin, though he inclines to the view that animal and vegetable evolution on the two planets would proceed on similar lines, so that if higher forms of life are present on Mars they would be comparable with those on the earth. He is less convincing on the subject of the hopelessness of arranging mutually intelligible signals, assuming the simultaneous desire to communicate and the conquest of the mechanical difficulties. There is little doubt that under these conditions the united intelligence of the two planets would at least make some progress in communication. The problem recalls the decipherment of cuneiform, being easier in some respects and more difficult in others.

A. C. D. C.

Land Reclamation.

ATTEMPTS are being made to reclaim some of the many waste acres in the British Isles, and the problems of reclamation are fully discussed in the 1919 volume of the Journal of the Royal Agricultural Society of England. The general problem is dealt with by Mr. W. Gavin. There is no definite information available as to the extent of either the total uncultivated land or the uncultivated land likely to be capable of cultivation in this country, but Sir Daniel Hall in his report to the Reconstruction Committee tentatively suggested 250,000 acres as the probable area reclaimable for agricultural purposes. Land reclamation has been going on more or less continuously since the beginning of agriculture, and in a closely settled country like England the greater part of the land showing prospects of immediate profitable cultivation has been reclaimed. Therefore, to reclaim the remaining waste land generally requires an expenditure in excess of the immediate value of the land when reclaimed. In some few districts there is land which would pay to reclaim, and in many cases private owners could do the work more cheaply than could the State. On the other hand, such reclamation adds to the national wealth more than the actual value of the land, so that the State can afford to spend more than a private owner. Further, in times of industrial depression it may be of social advantage to the State to provide employment by starting some reclamation schemes.

At a time such as this, when maximum home production is of vital importance to the well-being of the country, Mr. Gavin appeals to all landowners and occupiers to endeavour by some means to increase their cultivated-land area, even though it may not yield immediate profits. It must be remembered that some years must elapse before the full value of any reclamation scheme becomes apparent, though in any case the labour expended is never in vain, since the reclaimed land is sheer gain to the cultivated area, and means an increase not only in production, but also in national wealth by the commercial exchange promoted and the new addition of rates and taxes.

The scientific and technical problems of land reclamation are dealt with by Dr. E. J. Russell, who discusses especially the reclamation of sandy and clay soils. In devising reclamation schemes for a given area the first essential is to find the defects of the soil and then to decide on some means of remedying them. This cannot be done simply by analysis; field trials must be made, though analysis affords considerable aid by indicating the points on which the field tests should give information. Of the two methods possible the safer, but also the slower, is to set up on a typical part of the land to be reclaimed a series of trials based on the analytical data. The other method, which is quicker and almost as safe, is to compare in detail the waste land and the cultivated soil immediately surrounding it. In this way any important defects would be revealed and remedies could be considered.

For farming reclaimed sandy lands three methods are in general use: the winter feeding of sheep, market-gardening, and the growing of special crops. The last-named is practised at Methwold, where the reclamation scheme has been very successful. The crops grown are specially suited to the conditions, and an intelligent use of artificial fertilisers is required so as to reduce to a minimum the possibility of loss.

With regard to clay soils, reclamation can generally be effected either by conversion into arable land or by utilisation as grass land. In the arable land scheme lime is absolutely indispensable, while other manures, especially basic slag, are also necessary. If the land is to be used as grass land, there must be adequate drainage and heavy dressings of basic slag. If, however, the percentage of clay rises above certain limits—37 per cent. for a 30-in. rainfall and 35 per cent. for a 40-in. rainfall—then the grass scheme does not pay, for not only does drainage become too expensive, but also the grass suffers in dry weather by the shrinking and cracking of the soil. Such land, if allowed to run wild in England, is soon covered with a dense growth of bushes, and to reclaim this it is necessary first to clear the land and stub the roots, and then to improve the soil. These are expensive processes, and, although such schemes have been worked in some cases, it is improbable that any individual would undertake them at the present day. The only thing, therefore, is to hope that proper afforestation methods will be used.

University and Educational Intelligence.

CAMBRIDGE.—Dr. W. L. H. Duckworth, Jesus College, has been appointed to the newly created readership in anatomy, and Mr. V. C. Pennell, Pembroke College, as an additional junior demonstrator in anatomy.

New statutes have been framed for the establishment of the degrees of M.Litt. and M.Sc. for research students of the University. These will not be operative when approved until the change in the statutes can be effected, but they should be in operation in the coming academical year.

In connection with the growth of the department of biochemistry, it is proposed that two additional University lecturers and one additional demonstrator in biochemistry should be appointed.

Two fly-sheets have been circulated to resident members of the Senate in opposition to the scheme for a separate women's university at Cambridge—a scheme which is to be voted on next week. One comes, naturally, from the supporters of scheme A, which was defeated last term. The alternative offered by the other members of the Syndicate obviously has no more attractions now than formerly to those who wish to offer women full membership of the University. The second fly-sheet comes from the party which claims a desire to redress any real grievance under which women students suffer without giving them any hand in the control of men's education. The signatories of this report include three of the original signatories of report B, who now definitely oppose their own proposal. They urge the appointment of a new Syndicate to draft a statute giving women titular degrees with no voting power in the University, and reserving rights to the University over the number of women students whom it will undertake to teach. Other privileges, but no powers, are to be granted to the women, and machinery is to be provided by which women teachers could confer with the Boards of Studies in the University. It is something that the centre party on this question, with whom lies the ultimate decision between the two extreme wings, should have got so far forward as to admit the justice of the women's claims to degrees. The nature of the reception of their proposal by the women's colleges will be awaited with some interest, but it may be anticipated that at most it will amount to lukewarm acceptance, and that it will satisfy neither the women's desires nor demands.

The Lees Knowles lectures will be given by Major-Gen. Sir F. H. Sykes on "Aviation Before, During, and After the War."

LONDON.—H.R.H. the Prince of Wales has consented to accept the honorary degrees of Master of Commerce and Doctor of Science, which will be conferred on him on Presentation Day in May of this year. On only one occasion in the history of the University have honorary degrees been conferred—in 1903, when their Majesties the King and Queen (then Prince and Princess of Wales) received respectively the Doctorate of Laws and the Doctorate of Music. On the same day degrees were also conferred on Lords Kelvin and Lister, both of whom have since died. The Prince will thus be only the fifth honorary graduate of the University—the third on the roll of living persons on whom such degrees have been conferred.

SIR FREDERICK BLACK will distribute prizes and certificates at the Sir John Cass Technical Institute, Aldgate, on Thursday, February 10, and will unveil the memorial window erected by the governors of the institute to the memory of members of the staff and students who fell in the war. He will also give an address on "Liquid Fuel in Peace and War."

ON Tuesday next, February 8, at 8 p.m., Mr. F. H. Carr will open a discussion on "Post-Graduate Training in Industrial Chemistry" at a meeting of the Old Students' Association of the Royal College of Science, London, to be held in the Imperial College Union, Prince Consort Road, South Kensington. Non-members of the association interested in the subject are invited to be present. The annual dinner of the association, which had been arranged for February 8, has been postponed to Tuesday, March 8, when the annual general meeting will be held.

THE eighteenth annual dinner of "Old Centralians" (the Old Students' Association of the City and Guilds (Engineering) College of the Imperial College of Science, London) will be held at 7 p.m. on Friday, February 11, at the Hotel Cecil, London, and it is hoped that every past student of the college will make an attempt to be present. Invitations have been accepted by Sir A. Keogh, Prof. H. E. Armstrong, Sir Richard Gregory, the professors of the City and Guilds (Engineering) College, and others. Tickets (price 15s. each) may be obtained from Mr. G. W. Tripp, Lyndhurst, Hayes Road, Bromley, Kent.

The Military Education Committee of the University of London has arranged a course of six lectures on the scientific aspects of warfare, to be delivered on Mondays, commencing February 14, at 5.30 p.m., in the Theatre of King's College, Strand. The subjects of the lectures will be:—Chemical Warfare, Prof. A. J. Allmand; Transportation Services, Lt.-Col. F. R. M. de Paula; Wireless Telegraphy and Telephony, Mr. Philip R. Coursey; Military Railways, Lt.-Col. V. M. Barrington-Ward; Sound Ranging, Prof. E. N. da C. Andrade; and Intercommunication during the War, Major R. E. Priestley. Admission to the lectures is free, without ticket.

A copy of the first annual report of the library committee of the British Red Cross Society and Order of St. John Hospital Library has been received. The library is the outcome of a petition for the reorganisation of the War Library of the British Red Cross Society, and it has now a record of more than a year's splendid work behind it. The men of the Army and Navy who are still suffering from the effects of the war have the first claim on the library, after which civilian hospitals are supplied so far as possible. During the past year 33 British military hospitals oversea have received consignments of books from the library, while as many as 488 civilian institutions have been supplied. An interesting feature is the growing demand for special books by individual patients, and it is in this direction that readers of Nature may be of assistance. No request is made for funds, for it is estimated that the grant made by the British Red Cross Society will pay the working expenses of the library, but an urgent appeal is addressed to all who have books and magazines to spare. Gifts of books and papers should be sent to the British Red Cross Society and Order of St. John Hospital Library, 48 Queen's Gardens, London, W.2.

The Vice-Chancellor of the University of London, Dr. Russell Wells, visited the Horticultural College, Swanley, on January 27 and addressed the students. The occasion was a memorable one, for the college is now recognised by the University for preparation for the new degree of B.Sc. in horticulture. The Vice-Chancellor was greeted by Sir John Cockburn, acting chairman for the board of governors, and the principal, Miss F. M. G. Micklethwait, members of the board of governors, and other distinguished guests, including Dr. Goodchild (of the University of London), Mr. Dallinger (representing the Ministry of Agriculture), Dame Meriel Talbot, Mr. Salter Davies (Director of Education, Kent Education Committee), and Mr. Dykes (secretary of the Royal Horticultural Society), were also present. The Vice-Chancellor in his address said that he was one of those who had had a great deal to do behind the scenes with the founding of the new B.Sc. in horticulture, which had been proposed by Sir Albert Rollit. One of the difficulties had been to convince some of the members of the Senate that gardening was worthy of academic distinction. Practical experience proved, however, that the "rule of thumb" gardener could not progress far without expert advice, and he hoped in the future such advice would be provided by Swanley College.

Calendar of Scientific Pioneers.

February 3, 1862. Jean Baptiste Biot died.—Biot worked assiduously all his life at physics and made valuable contributions on the polarisation of light. His famous balloon ascent with Gay-Lussac, his geodetical work with Arago, his biographical writings, and his activity as a member of the French Institute all made his name widely known.

February 3, 1890. Christoforus Henricus Diedericus Buys-Ballot died.—Director of the Meteorological Institute and professor of experimental physics at Utrecht, Buys-Ballot was an initiator of weather reports and international meteorology.

February 3, 1894. Edmond Frémy died.—The author with Pelouze of a large treatise on chemistry, Frémy was an investigator and teacher of industrial chemistry, and in his later years succeeded in making artificial rubies.

February 4, 1615. Giovanni Battista della Porta died.—The compiler of "Magia Naturalis," a volume of physical experiments, and the inventor of the camera obscura, Porta rendered many services to the science of his day.

February 5, 1907. Nikola Alexandrovitch Menschutkin died.—A contemporary and fellow professor of Mendeléeff at Petersburg, Menschutkin added to the knowledge of chemical structure and was a pioneer in the study of chemical dynamics.

February 6, 1804. Joseph Priestley died.—Five years younger than Black and two years younger than Cavendish, Priestley—the father of pneumatic chemistry—was born near Leeds in 1733, and was trained for the Nonconformist ministry. Attracted to the study of chemistry and electricity, he discovered several gases. His discovery of oxygen or "dephlogisticated air" was made in 1774, when he was librarian to Lord Shelburne. In spite of his own discoveries, Priestley clung to the phlogistic theory, leading Cuvier to describe him as "le père de la chimie moderne qui ne voulait pas reconnaître sa fille." From 1780 to 1791 he was a Unitarian minister at Birmingham. A lover of freedom and known for his sympathy with the French Revolution, on the second anniversary of the fall of the Bastille, July 14, 1791, a mob set fire to his house. His library, apparatus, note-books, and register of experiments were all destroyed. Priestley himself fled to Heath Forge, near Dudley, and thence by Kidderminster and Worcester to London. Three years later he sailed for America, passing the last ten years of his life at Northumberland, Pennsylvania.

February 7, 1903. James Glaisher died.—Head of the magnetical and meteorological department at Greenwich Observatory, Glaisher made many balloon ascents for scientific purposes.

February 9, 1811. Nevil Maskelyne died.—Like Lalande and Messier, Maskelyne was attracted to astronomy by the solar eclipse of July 25, 1748. He became Astronomer-Royal in 1765, founded the Nautical Almanac, and made improvements in methods of observing.

February 9, 1865. James Melville Gilliss died.—Trained for the United States Navy, Gilliss published the first American volume of astronomical observations and prepared the first American star catalogue. In 1861 he succeeded Maury as director of the Naval Observatory at Washington.

February 9, 1883. Henry John Stephen Smith died.—Savilian professor of geometry at Oxford, Smith did important work in elliptic functions, theory of numbers, and modern geometry. He has been called the greatest disciple of Gauss.

E. C. S.

Societies and Academies.

LONDON.

Geological Society, January 19.—Mr. R. D. Oldham, president, in the chair.—Dr. L. J. **Wills** and B. **Smith**: The Lower Palæozoic rocks of the Llangollen district, with especial reference to the tectonics. The general sequence of rocks and details of their components in various localities are given. The Lower Palæozoic rocks are, in the main, folded on approximately east-and-west axes, to which the cleavage and some of the major faults are closely parallel in direction. The folding and part of the faulting are Devonian, and appear to have set up torsional stresses affecting a greater area than that considered here. The concertina-folding in the synclinoria appears to be related to the tough anticlinal nodes of the northern Ordovician outcrops. The master-faults separate blocks of country which appear to have been displaced laterally in post-Carboniferous times. The minor faults appear to be adjustments that allow the strata to comply with torsional stresses.

PARIS.

Academy of Sciences, January 3.—M. G. Lemoine in the chair.—E. **Picard**: Certain functions connected with closed surfaces.—P. **Termier** and L. **Joleaud**: The age of transport phenomena in the region of Avignon.—L. **Fabry**: The use of geocentric latitudes for facilitating the identification of the minor planets. Two minor planets were notified in Circular 138 of the Marseilles Observatory which appeared to be new. The author has applied the method of geocentric latitudes to the photographic observations, and shows that one of these is identical with Mnemosyne (57).—R. **de Forcrand**: The melting point of heptane and the law of alternation of melting points. Hexane gave a melting point of −93·5° C., as against −95° C. found by Guttmann, and octane −57·4° C. (Guttmann −98·2° C.). It has been shown that the melting points of many series of carbon compounds show an irregular-toothed curve, such that in passing from a compound with an even number of carbon atoms to the next higher homologue with an odd number the melting point fell. The data for the C_1 to C_8 paraffin hydrocarbons appeared to give an exceptional curve, but with the substitution of −57·4° C. for the −98·2° C. of Guttmann the curve becomes normal, and would indicate −94° C. as the melting point of heptane. Pure heptane was prepared and found to have a melting point of −94·75° C.—H. **Parenty**: The reconstitution of certain invisible details of old pictures. With reference to a recent paper by A. Chéron on the use of radiography for the recognition of ancient pictures, the author recalls a paper published in 1913 in which photography was used for the same purpose, and mentions two cases in which his conclusions based on ordinary photographs have been confirmed.—P. **Vuillemin**: The aberrations of floral symmetry.—M. **Angelesco**: Certain completely integrable linear differential equations.—A. **Petot**: Shocks in the change-gears of motor-cars.—M. **Dumanois**: The determination of a criterion of general fatigue in internal-combustion motors. A discussion of a formula for the factor of safety in the construction of internal-combustion motors, with special reference to Diesel engines.—H. **Corblin**: A compressor with a membrane. The gas compressor described and illustrated has, in effect, a liquid piston, with an elastic metallic membrane separating the liquid and the gas being compressed. The compression is nearly isothermal, and air can be carried from atmospheric pressure to 100 kg. per sq. cm. at one step.—J. **Guillaume**: Observations of the sun made at the Lyons Observatory during the third quarter of 1920. Observations were made on eighty-eight days during the quarter and the results are shown in three tables, giving the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—L. A. **Herdt** and R. B. **Owens**: The direction of ships at the entrance of ports and channels by a submerged electric cable. An account of experiments carried out in Canada in 1904, and suggestions for the development of the method.—M. **Liénard**: Scalar and vector potentials due to the motion of electric charges. A formula recently developed by Anderson (*Phil. Mag.*, August, 1920) is not in agreement with one given by the author in 1898. A mathematical investigation of the cause of the discrepancy is given.—G. **Ferrié**, R. **Jouaust**, R. **Mesny**, and A. **Perot**: Studies in radiogoniometry. Under normal conditions the direction of the electromagnetic waves in wireless telegraphy can be determined within 1°, but under certain conditions the azimuth of a transmitting post varies capriciously, and at certain times during the day no position can be found. These effects have been carefully studied, but although there is some evidence of a seasonal influence the exact cause of these deviations has not yet been elucidated.—A. **Chéron**: The radiography of pictures. In the preparation of the canvas at the present time white lead is used, whilst in early times calcium carbonate and wax were preferred. These differ markedly in transparency to the X-rays, and the materials of old and modern paints also show differences in this respect. Hence radiography may serve to distinguish between old and modern pictures, and in certain cases can bring out restorations.—E. **Rengade**: Saline double decompositions and the phase rule. It is shown by experiment that if a mixture of sodium nitrate and ammonium chloride is treated with a quantity of water insufficient for complete solution, crystals of sodium chloride are formed. This is opposed to the conclusion arrived at by M. Raveau in a recent communication.—G. **Denigès**: Remarks on a recent note by M. A. Bolland on the microchemical reactions of iodic acid. A claim for priority.—A. **Kling** and D. **Florentin**: The properties and constitution of the group $(CO.Cl_2)$. The complete substitution of hydrogen by chlorine in the group $—OCH_3$ gives rise to abnormal properties. From its reactions it has a modified structure and behaves as phosgene *plus* chlorine.—C. **Dufraisse**: The ethylene isomerism of the ω-bromostyrolenes. Both these stereo-isomers are liquids at the ordinary temperature, and differ in colour and smell. An account is given of their reciprocal transformations.—J. **Durand**: The action of the alkaline metals on the ether oxides. It has hitherto been supposed that ordinary ethyl ether and its homologues are without action on sodium and the other alkaline metals, but the author shows that this is not the case. Details of the reaction between sodium (or the liquid alloy of sodium and potassium) on ethyl and *iso*amyl ethers, veratrol, ethylbenzyl ether, and diphenyl ether are given. The exact mechanism has still to be worked out.—F. **Grandjean**: The existence of equidistant differentiated planes normal to the optic axis in liquid crystals.—P. **Négris**: The glacial oscillations of the Quaternary period and the corresponding movements of the lithosphere.—E. **Chaput**: Observations on the ancient alluvium of the Seine.—E. **Mesnard**: Contribution to the history of earthquakes.—P. **Lesage**: Saline plants and period of anomalies.—G. **Nicolas**: Contribution to the study of the mechanism of the fertilising action of sulphur. Sulphur increases the assimilation of carbon from the air by the action of chlorophyll.—M. **Barlot**: A new reagent for Lactarius and Russula. The reagent is methyl chloroantimoniate in methyl alcohol solution. The colour reactions with eighteen species of Russula are given.—A. **Pézard**: The law of "all or nothing" or of functional constancy relating to the action of the testicle.—M. **Bezssonoff**: The antiscorbutic action of raw potato, ground and intact.—J. **Nageotte**: The structure of the cornea.—R. **Dubois**: Maternal affection in the electric skate (*Torpedo mormorotae*). Just before the birth of her young a specimen of this fish gave strong electric shocks, but after the birth of seven young the fish, although vigorous, gave no more shocks, and with the young fish about it could be readily handled. When the young were removed the shocks were as strong as before. This shows that the electrical discharge is not a reflex action, but voluntary, and can be suppressed when likely to be a danger to the young.—MM. **Cluzet**, **Rochaix**, and **Kofman**: The bactericidal action of the radiation from radium tubes employed in radium therapy.—F. **d'Herelle**: The bacteriophage micro-organism, the agent of immunity in plague and barbone.—A. **Paine** and A. **Peyron**: The neoplasic transformation of striated muscular fibre with visceral metastasis in the evolution of experimental sarcoma in birds.

Books Received.

Basic Slags: Their Production and Utilisation in Agriculture. (A General Discussion held by the Faraday Society on Tuesday, March 23, 1920.) Pp. 259–335. (London: The Faraday Society.) 7*s*. 6*d*.

The Botanical Society and Exchange Club of the British Isles. Vol. v., part v. Report for 1919. (Arbroath: T. Buncle and Co.) 7*s*. 6*d*.

The Observer's Handbook for 1921. (Thirteenth year of publication.) Pp. 64. (Toronto: Royal Astronomical Society of Canada.)

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The Bahama Floras. By Prof. N. L. Britton and Dr. C. F. Millspaugh. Pp. viii+695. (New York: Published by the authors.)

Introduction to Qualitative Chemical Analysis. By Th. W. Fresenius. Seventeenth edition of the original work by C. R. Fresenius. Translated by C. Ainsworth Mitchell. Pp. xx+954. (London: J. and A. Churchill.) 36*s*. net.

Department of Marine Biology of the Carnegie Institution of Washington. Vol. x.: The Echinoderm Fauna of Torres Strait: Its Composition and its Origin. By H. L. Clark. (Publication No. 214.) Pp. viii+223+38 plates. (Washington: Carnegie Institution.)

Diseases of the Ear. By Dr. P. D. Kerrison. Second edition. Pp. xxi+596+vi plates. (Philadelphia and London: J. B. Lippincott Co.) 35*s*. net.

Chemie der Hefe und der Alkoholischen Garung. By Prof. H. Euler and Prof. P. Lindner. Pp. x+350+2 Tafel. (Leipzig: Gustav Fock.)

Kieselsaure und Silicate. By H. Le Chatelier. Berechtigte Uebersetzung by Dr. H. Finkelstein. Pp. xi+458. (Leipzig: Gustav Fock.)

Piezochemie Kondensierter Systeme. By Prof. E. Cohen and Dr. W. Schut. Pp. ix+449. (Leipzig: Gustav Fock.)

Die Chemische Literatur und die Organisation der Wissenschaft. By W. Ostwald. Pp. iv+120. (Leipzig: Gustav Fock.)

A Dictionary of Applied Chemistry. By Sir Edward Thorpe. Vol. i.: A–Calcium. Revised and enlarged edition. Pp. x+752. (London: Longmans, Green and Co.) 60*s*. net.

Ancient Egypt. Part i., 1921. (London and New York: Macmillan and Co.; Boston: Egyptian Research Account.) 2*s*.

A Manual of Photographic Technique: Describing Apparatus, Materials, and the Details of Procedure. By L. J. Hibbert. Pp. x+118. (London: Sir I. Pitman and Sons, Ltd.) 2*s*. 6*d*. net.

Diary of Societies.

THURSDAY, February 3.

Royal Institution of Great Britain, at 3.—Prof. W. A. Herdman: Oceanography (Great Exploring Expeditions).

Royal Society, at 4.30.—Dr. G. B. Jeffery: The Field of an Electron on Einstein's Theory of Gravitation.—Dr. M. N. Saha: A Physical Theory of Stellar Spectra.—W. F. Darke, J. W. McBain, and C. S. Salmon: The Ultra-microscopic Structure of Soaps.—Dr. J. Mercer: Linear Transformations and Functions of Positive Type.

China Society (at School of Oriental Studies), at 5.—E. H. C. Walsh: Central Tibet and Lhasa.

Linnean Society, at 5.—Miller Christy: Wistman's Wood, Dartmoor; Specimens of Slides.—Dr. Agnes Arber: Leaf-tips of Monocotyledons.—T. A. Dymes: Seedlings of *Ruscus aculeatus*, with Remarks on their Germination and Growth.

Royal Aeronautical Society (at Royal Society of Arts), at 5.30.—Major G. Dobson: The Use of Meteorology to Aviation and *Vice-versa*.—Wing-Comdr. H. W. S. Outram: Ground Engineering.

Royal Society of Medicine, at 5.30.—Prof. F. Hobday: The Diseases of Animals which are Contagious to Man.

London Dermatological Society, at 6.—Dr. W. Griffith: Parasitic Diseases of the Skin (Chesterfield Lecture).

Chemical Society, at 8.—Informal Meeting.

Royal Society of Medicine (Obstetrics and Gynæcology Section), at 8.—F. C. Pybus: An Unusual Type of a Tuberculous Peritubal Cyst.—Dr. T. W. Eden and F. L. Provis: X-ray Treatment of Uterine Fibroids and Chronic Metritis.

FRIDAY, February 4.

Royal Society of Medicine (Laryngology Section), at 4.

Royal Astronomical Society (Geophysical Discussion), at 5.—On Gravity at Sea: Opened by Prof. G. W. Duffield, and continued by Sir S. G. Burrard, Dr. H. Jeffreys, Dr. J. W. Evans, and Dr. A. M. Davies. Chairman: Sir Arthur Schuster.

Royal College of Surgeons of England, at 5.—Prof. C. W. G. Bryan: The Early and Late Effects of Injuries of the Diaphragm, with Special Reference to Wounds jointly involving Thoracic and Abdominal Viscera.

Institution of Mechanical Engineers (Informal Meeting), at 7.—F. R. Wade and Others: Our Part in the Industrial Crisis of To-day.

Junior Institution of Engineers, at 8.—W. H. Ballantyne: Surface Tension and Some of its Industrial Applications.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Drs. Rowbotham and I. Magill: Anæsthesia in the Plastic Surgery of the Face and Jaws.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. A. D. Waller: The Electrical Expression of Human Emotion.

SATURDAY, FEBRUARY 5.

GILBERT WHITE FELLOWSHIP (at 6, Queen Square, W.C.1), at 3.—Lecture.

MONDAY, FEBRUARY 7.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Dr. A. J. McC. Routh: Motherhood.
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. H. Platt: The Surgery of the Peripheral Nerve Injuries of Warfare.
SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—Lord Headley: Presidential Address.
ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street), at 8.—Prof. R. F. A. Hoernle: Contributions to a Phenomenology of Meaning.
SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—Dr. O. Silberrad: The Erosion of Bronze Propellers.
SURVEYORS' INSTITUTION, at 8.—A. H. Davis: The Acquisition of Land for Public Purposes in Egypt.
ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Dr. J. M. Arthur: Mount Kenya.
MEDICAL SOCIETY OF LONDON, at 9.—G. E. Gask: Surgery of the Lung and Pleura (Lettsomian Lecture).

TUESDAY, FEBRUARY 8.

ROYAL HORTICULTURAL SOCIETY, at 3.
INSTITUTION OF CIVIL ENGINEERS, at 5.30.—G. Ellson: Cannon Street Bridge Strengthening.—F. W. A. Handman: Reconstruction of a Viaduct.
ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. P. Chalmers Mitchell: Report on the Additions made to the Society's Menagerie during the months of November and December, 1920.—Dr. C. F. Sonntag: I. The Comparative Anatomy of the Tongues of the Mammalia. II., Fam. Simiidæ. 2. A Contribution to the Anatomy of the Three-toed Sloth (*Bradypus tridactylus*).—Prof. J. P. Hill: Exhibition of, and Remarks upon, a Fœtus of the Three-toed Sloth (*Bradypus tridactylus*).—R. I. Pocock: Notes on the External Anatomy of the Three-toed Sloth (*Bradypus tridactylus*).—Lieut.-Col. S. Monckton Copeman: Note on the Capture of a Rare Parasitic Fly, *Hammomyia* (*Hylephila*) *unilineata*, Zett.—D. M. S. Watson: The Basis of Classification of the Theriodontia.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—R. Davis: A New Method for the Measurement of Photographic Filter Factors.—F. C. Toy: A Description of a Monochromatic Illuminator designed for a Special Purpose.—Dr. L. A. Levy and T. Thorne Baker: High-speed Radiography.
QUEKETT MICROSCOPICAL CLUB (at 11 Chandos Street, W.1), at 7.30.—Annual General Meeting.
ROYAL SOCIETY OF ARTS, at 8.—E. C. de Segundo: Some of the Problems of Unemployment.
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Prof. A. Keith: Tailed Men.
ROYAL SOCIETY OF MEDICINE (Psychiatry Section), at 8.30.—Dr. W. A. Potts: Mental Tests.

WEDNESDAY, FEBRUARY 9.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. H. Platt: The Surgery of the Peripheral Nerve Injuries of Warfare.
ROYAL SOCIETY OF MEDICINE (Surgery: Proctology Sub-section), at 5.30.—W. B. Gabriel: The Results of an Experimental and Histological Investigation into Seventy-five Cases of Rectal Fistulæ.—H. Graeme Anderson: Method of Abdomino-perineal Excision of the Rectum in Three Stages.
INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—J. H. Barker: Machinery Applied to Mass Production.
ROYAL SOCIETY OF ARTS, at 8.—Prof. W. Rothenstein: Possibilities for the Improvement of Industrial Art in England.
INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.
INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at 28 Victoria Street), at 8.

THURSDAY, FEBRUARY 10.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. A. Herdman: Oceanography (Problems of the Plankton).
ROYAL SOCIETY, at 4.30.—Rev. John Roscoe: A *Résumé* of the Results obtained by the Mackie Anthropological Expedition to Uganda.
LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Prof. A. S. Eddington: World Geometry (Lecture).
INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Discussion on Electric Appliances for Domestic Purposes, to be introduced by Dr. E. Griffiths and F. H. Schofield in a Paper on Some Thermal Characteristics of Electric Ovens and Hot Plates.
OPTICAL SOCIETY, at 7.30.—R. S. Whipple: The Design and Construction of Scientific Instruments.—T. Smith: The Galilean Binocular.—R. J. Trump: A Shutterless Continuous-feed Kinematograph.
ROYAL SOCIETY OF MEDICINE (Neurology Section) (at National Hospital for Paralysis and Epilepsy), at 8.

FRIDAY, FEBRUARY 11.

GILBERT WHITE FELLOWSHIP.—Founders' Day Celebrations.
ROYAL ASTRONOMICAL SOCIETY (Anniversary Meeting), at 5.
ROYAL SOCIETY OF MEDICINE (Clinical Medicine, Surgery), Joint Meeting, at 5.—Dr. H. Mackenzie, J. Berry, and Others: Discussion: The Medical and Surgical Treatment of Graves' Disease.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. G. T. Fisher: Loose Bodies in Joints.
PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.15.—Discussion on Absolute Measurements of Electrical Resistance, and Instruments Based on the Temperature-variation of Resistance.—Sir Richard Glazebrook and F. E. Smith: Absolute Measurements of Electrical Resistance.—Resistance Thermometry: Prof. H. L. Callendar: The Compensated Resistance Bridge, and Instrument for the Measurement of Radiation.—C. R. Darling: The Early Work of Siemens on the Resistance-Pyrometer.—C. Jakeman: The Measurement of Steam Temperatures.—The Hot-Wire Microphone: Major W. S. Tucker: The Function of the Convection Current in the Hot-Wire Microphone.—Capt. E. J. Paris: Theory of the Tucker Microphone.—Anemometry and Heat Convection: Prof. J. T. McGregor Morris: A Hot-Wire Anemometer.—Dr. J. S. G. Thomas. A Directional Hot-Wire Anemometer.—A. H. Davis: An Instrument for Measuring Convected Heat.—Miscellaneous Applications: Dr. G. A. Shakspear: A Gas Permeameter.—Prof. Leonard Hill: The Caleometer.—E. A. Griffiths: Liquid Depth Gauge (Distant Reading Type).—Dr. Daynes: A CO_2 Recorder.—Dr. E. Griffiths: Electrical Hygrometers.
MONTESSORI SOCIETY (at University College), at 5.45.—Miss M. Drummond: The Psychological Basis of the Montessori Method.
ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—B. T. Lang: Scotometry.—Dr. T. H. Butler: Late Infections after Sclerectomy.—M. L. Hepburn: Some Notes on Trephining.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. F. W. Aston: Isotopes and Atomic Weights.

SATURDAY, FEBRUARY 12.

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THURSDAY, FEBRUARY 10, 1921.

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The Promotion of our Optical Industries.

THE Government has promised to introduce in the House of Commons early next session a Bill to safeguard and foster certain key industries in this country. Of these the optical glass and optical instrument industries deserve special consideration, for their importance is likely to be overlooked because they are relatively small industries, not employing large aggregations of capital or big numbers of firms and employees. It is dangerous for any nation to estimate the value and necessity of a particular industry by taking account merely of the capital sunk in it and of the number of people it employs. It is rather to the character of the industry and to the part it plays in the industrial life of the nation, both in peace and in war, that we must look if we are rightly to measure its intrinsic national value.

There are differences of opinion as to the best method of promoting the development of an incipient industry, whether by subsidies or by safeguards against unrestricted and unregulated foreign competition, but there is none as to the need for immediate action in the case of industries which are essential to the proper functioning of the nation's industrial system in peace and are vital to its safety in war. Adequate measures must be taken to foster these key industries, regardless of whether a general economic principle, sound in ideal circumstances or as a general proposition, is violated.

It is not difficult to show that the manufactures of optical glass and of optical instruments fall in this category. First, it must be realised that the manufacture of optical instruments in this country stands or falls with the manufacture of optical glass in this country. If the British optical instrument industry is to be maintained and to develop so as to turn out products equal, at least, to the best products of other nations, it must not be dependent on foreign sources for the supply of optical glass, but must have an adequate home supply, equal, again, at least to the best available anywhere. Owing mainly to our national neglect of scientific workers, supremacy in the optical glass industry, which was established in this country as early as 1837, passed over to Germany, the Government of which had the insight and the foresight to gauge its actual and potential value. Not only did the Prussian Government bear the expense of the prolonged series of scientific investigations commenced by Schott and Abbe in 1881, but also, in order to capture the world trade, large State subsidies were made continuously to the industry down to the declaration of war in 1914. In that year there was but one firm manufacturing optical glass in the British Empire, with the consequence that during the first year of the war our armies and our fleets could not be equipped with the optical glass required.

By the intensive research of our scientific workers; by lavish expenditure; by the energetic enterprise of manufacturers in building workshops, installing plant, and, under conditions of great difficulty, training labour to perform the highly skilled operations needed, these deficiencies were overcome; and by the end of the war British optical glass was as good as German, and it was being produced in quantities sufficient to meet every demand. The optical instrument industry developed correspondingly, and instruments for all the varied purposes of the Army, the Navy, and the Air Force were manufactured equal to, and in many cases surpassing, the best that Germany could make. The position now is that we have the buildings, the plant, the organisation, the technical knowledge and the technicians, and the skilled labour needed to maintain these industries at their present high level of efficiency. Moreover, as a guarantee of future progress, the industry has established the British Scientific Instrument Research Association, and the Imperial College of Science and Technology has formed a Department of Technical Optics, so that the study of this branch of science, hitherto neglected in this country, may be raised to the highest university status.

It is undeniable that the preservation of the optical glass and optical instrument industries is absolutely vital in war. The skilled labour needed for this industry cannot be hurriedly improvised, as it can and was, for example, in the engineering trades. There is no kindred industry from which, for example, the optical glass grinders and polishers can be drawn in time of emergency. The optical glass maker and the optical instrument maker require a long training, and if these industries are allowed to decline and another war occurs, we shall find ourselves in a position more dangerous even than was our situation in 1914.

A flourishing and efficient optical instrument industry is not less vitally important to the nation's peaceful pursuits than it is for purposes of warfare. The general use of optical instruments in industries is growing and must grow. The increasing use of the microscope in the textile and steel industries, and the application of the polarimeter for testing purposes in the sugar and essential oil industries, are but two of many examples that could be cited to show the growing dependence of our great national industries upon the optical instrument industry. The development and perfection of optical instruments and the invention of new types in this country will be brought to a standstill unless the instruments are manufactured here, where British inventors and designers can keep in close touch with the manufacturers. Moreover, this industry, springing directly from the loins of science, and progressing as scientific knowledge widens, is one of the most highly skilled industries we have. Its expansion means a definite increase in the numbers of technical scientific workers and of the most highly skilled artisans; and the national wealth, in any comprehensive conception of the term, must be increased by the increase of the numbers of such educated and skilled classes.

What is the position of these industries to-day? As the *Daily Telegraph* says in a leading article on January 6: "The industry is again exposed to the full blast of German competition, more formidable now than ever because of the state of the German exchange." Open competition, in these abnormal circumstances, is impossible.

There are two main objects which the Bill to be introduced should secure and reconcile. On one hand, if the industry is to be saved, the manufacturers must be protected from foreign competition aggravated by the state of the exchange; and, on the other, the users of scientific instruments must not be prejudiced or hampered, either by being unable to obtain the best instruments or by having to pay an extravagant price for them. These apparently conflicting interests are not merely reconcilable; they are interdependent. If the British optical instrument industry should dwindle and die, the scientific users of instruments will be at the mercy of foreign manufacturers, they will have to pay a heavy price for such dependence, and they will be handicapped as compared with scientific workers in foreign countries possessing a flourishing scientific instrument industry. Similarly, if the scientific users cannot obtain the best instruments for their work, or if they have to pay an exorbitant price for them, their work will be hampered, their demand for instruments will decrease, and the manufacturers will ultimately suffer.

The industries, through the British Optical Instrument Manufacturers' Association, ask shortly for the following measures of protection:—

(1) No optical glass or scientific instruments to be imported into this country for a period of, say, seven years, except under licence.

(2) Such licences only to be granted in respect of goods which are not being made in Great Britain in the required quantities or of the required quality.

(3) An expert licensing committee to be set up.

(4) The optical instrument manufacturers are prepared, in order to guarantee reasonable prices, to submit to a control of profits.

The manufacturers are satisfied and confident that, under such conditions for a limited period, they would be able to establish the optical glass and optical instrument industries on a sound and stable basis, and also be able at the end of the period to meet any foreign competition in the open market. On the other hand, unless they secure this limited protection, it is more than probable—indeed, it is almost certain—that the manufacture of optical glass in this country will cease, and that, in consequence, some of the largest British manufacturers of optical instruments will greatly curtail their production. The proposed measures seem to protect adequately the interests of the scientific users. Moreover, such a system of control of imports for a limited period seems preferable to anything in the nature of a permanent tariff. It is not likely to have on the industry the emasculating effect of a protective tariff; provided that the period be limited, and that the licensing committee adopt an enlightened policy, prohibition of imports, except under licence, is rather calculated to act as a stimulus on the development of the industry.

There is, finally, one point not dealt with in the proposals outlined above. In return for this shield from danger during a limited period, the country may well ask: What guarantee is there that the manufacturers are taking due measures to promote and prosecute the scientific research and scientific methods on which alone ultimately these, or any other, industries can be made efficient and able to stand against foreign competition? The leading manufacturers have combined to form a scientific instrument research association, and in addition many of them are engaged continuously in scientific research. But it is not clear that all the manufacturers who are demanding the legislative measures outlined above are contributing in either or both of these ways to the advancement of the industry. It is worth considering whether the proposed licensing committee should not take this factor into consideration in any specific case in which it is asked to grant or to refuse a licence.

British Mammals.

British Mammals. Written and illustrated by A. Thorburn. (In two volumes.) Vol. i. Pp. vii+84+25 plates. (London: Longmans, Green, and Co., 1920.) Price 10*l.* 10*s.* net two vols.

THE success of "British Birds" and "A Naturalist's Sketch-book" has induced Mr. Thorburn and his publishers to issue companion volumes on "British Mammals," the first of which is now before us. Although the subject of our native beasts has already been somewhat exhaustively dealt with by Millais, Barrett-Hamilton, Harting, Lydekker, Coward, Adams, etc., there is yet room for Mr. Thorburn's book, because he is an artist-naturalist of such unique quality and observation that anything he may give us is worthy of publication and permanent value. In his case the common truism that there is always room at the top applies definitely. Pictures of natural history are always in demand, and we cannot have too many of those of the highest quality, since the exponents who possess genius are so few. Wherefore, even if the author's text is short, it is quite sufficient and extremely accurate so far as it goes, whilst the illustrations of the various species and subspecies, especially the smaller ones, are of such remarkable accuracy and beauty that it is not too much to say they have not been, and never will be, surpassed. Where Mr. Thorburn excels all other artists of mammals or birds is in his supreme rendering of the colour and texture of fur and feather, as well as in his perfect association of natural background with the subject under treatment. He also introduces just the right botanical features found in association with the creatures he depicts, and skilfully inserts little and surprising notes of colour, such as a bluebell, an orange-tip butterfly, a golden kingcup, or a humble daisy, which often makes a charming picture out of what is really a dull and unattractive subject. This is pure skill, and the result of a severe artistic training combined with a knowledge of Nature.

Those of us who collect books of naturalist history find that there are few the text and illustrations of which stand the test of years. Processes of reproduction, as well as science and observation, are apt to become out-of-date and useless to the practical naturalist of to-day, since within the last few years this class of art and literature has reached a level never approached in past times. "The value of a book," once said Lord Rosebery, "is its price in the second-hand catalogues." Wherefore it behoves us, in these days of heavy expenditure and high taxation, to purchase our treasures with an eye to the future, and those of us who can afford a "Thorburn" book will be wise, for the work of this great artist must be limited, and will certainly rise in value.

The artist's pictures of dormouse, hedgehog, badger, fox, shrews, and various species of bats are quite little gems. His eye sees with Pre-Raphaelite exactness almost every hair on the lesser shrew, the smallest mammal in the world, and gives it that delicious softness which it possesses. If there is one picture that is a *tour de force,* it is the mole, a very difficult creature to paint. We have kept a mole alive and seen it gobbling a worm with the almost indecent haste so admirably depicted. There is the correct and strenuous position of the hind-legs, the holding of the powerful fore-paws, and the perfectly rounded line of the head as it gobbles its prey with a true gourmand's rapidity. Most artists would be content to paint just a dead mole, but Mr. Thorburn gives it life and character. Space does not permit us to criticise the numerous plates in which the artist has succeeded in giving us satisfactory renderings of our native beasts. He has a critical audience to satisfy, since he is apt to think that we now know our own mammals, few in number though they are; but special attention may be directed to the bats, which, although unlovely things, yet require an accuracy of delineation that calls for the highest care and exactitude. Mr. Thorburn has evidently taken the trouble to depict these somewhat elusive beasts from life, and is to be congratulated on his success. No artist-naturalist, however, is free from criticism, and if we find fault with a few inaccuracies, they are only such as occur in all works where fresh models are unavailable.

In the case of the bearded seal—a rare mammal that, Mr. Thorburn says, has occurred only once in British waters (twice would be more accurate, as a specimen was killed in the Beauly Firth a few years ago, and recorded in the *Field*)—the artist has evidently painted his picture from a cured skin in which the oil and tanning have spoiled the original colour, which in Nature (as we have seen) is a fine pearly grey. The eyes, too, are round and prominent, as in the common seal, and not sunk and overshadowed by the cranial sockets. The picture, too, of the otter is not a success, the neck being far too long. Also we are not enamoured with the little pen-and-ink tailpieces. Some are fairly good, but the majority are drawn too coarse to render fur accurately. This is doubtless due to the fact that the book is printed on a pure hand-made paper, which, whilst admirable for the text, does not permit the use of anything but blocks exhibiting coarse lines. It is to be regretted that, as yet, English firms of reproducers are still far behind those of the Continent in this class of reproduction.

These and a few other inaccuracies of detail are, however, but trifling detriment in a work which will always remain one of permanent value, and both Mr. Thorburn and his publishers are to be congratulated on having issued so valuable and magnificent a production. We look forward with pleasure to the second volume, which, if it is as good as the first, will satisfy the most exacting naturalists and connoisseurs of beautiful art-books.

Improvement of the Race.

Applied Eugenics. By Paul Popenoe and Prof. Roswell Hill Johnson. (Social Science Text-books.) Pp. xii+459. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1920.) Price 14*s*. net.

EVERYONE is agreed as to the desirability of improving the intrinsic qualities of the race, but the difficulty is to know what can wisely be done. The question, What is practicable? is much harder to answer than the question, What is desirable? But towards an answer to the more difficult question this very competent book by Mr. Paul Popenoe and Prof. Roswell Hill Johnson makes a definite contribution. "Emphasis has been laid on the practical means by which society may encourage the reproduction of superior persons and discourage that of inferiors."

The authors begin by estimating the relative importance of the two indispensable factors—hereditary nature and environing nurture. Their reasoned bias is evident in the sentence: "It is his nature, not his nurture, that is mainly responsible for his character." Perhaps it is not very profitable to discuss which of two necessary components is the more important in a resultant. So far as social efficiency in the wide sense is concerned—which includes character and working power—we hold that the man with five talents often goes further than the man with ten, simply because his nurture was better. But we have no statistics to prove this. The authors go on to a shrewd discussion of the transmissibility of exogenous modifications, giving as their verdict "Not proven." But here, again, they seem to us to draw their bow too tightly, not attaching sufficient importance to the *rôle* that nurtural peculiarities may have as the liberating stimuli of germinal variations. From emphasis on "nature" rather than on "nurture" and from rejection of the postulate of transmissible modifications, the authors pass logically to the conclusion that man is much more "born" than "made"; so what eugenics must look forward to is having more children well born. What this means biologically is clearly explained in the chapter on the laws of heredity. Civilised man has to some extent thrown off the yoke of natural selection—a fact that in itself suggests the desirability of some other mode of sifting to safeguard the interests of the race. This desirability is corroborated by the fact that where natural selection still operates on civilised mankind, especially in the way of a differential death-rate, it is not doing much to improve the race. In some ways it is rapidly hastening race degeneracy. It is here that practical eugenics comes in with suggestions towards "raising the level of the race by the production of fewer people with physical and mental defects, and more people with physical and mental excellences." What are these suggestions?

The first suggestion is the restriction of the marriage and reproduction of defectives. Good stock is spoiled by mingling with bad; many infants would better not be born; much misery is perpetuated; the cost to the State is enormous. The proposal is "to prevent the reproduction of those feeble-minded, insane, epileptic, grossly defective or hopelessly delinquent people, whose condition can be proved to be due to heredity, and is therefore probably transmissible to their offspring." But how is the restriction to be effected? The authors answer: By segregation, sterilisation in certain cases, and a good banns law. Besides these coercive methods, the first of which is regarded as urgently necessary, the authors look to an increasingly enlightened social conscience. The objections to coercive methods are considered in a fair-minded and temperate manner, but we confess to have less faith than the authors have in the wisdom of tribunals. We should not like our neighbours to decide whether we are to have permission to marry, and it is well known that such conditions as feeble-minded and epileptic are not very precise. It is interesting to speculate what human history would have been if eugenics boards had segregated—well, perhaps we had better not mention names.

On the positive side the authors write admirably. Sex-selection is a reality; if it were better educated and given wider opportunities, it might become a very potent factor in racial progress. To promote a higher marriage-rate among superiors, the authors make a plea for clean living, for simpler living, for a wider education of faculties, for a franker approbation of the married state as more normal than celibacy, and against the persistent prolongation of the training period beyond the early twenties. At the same time, the authors assure us that the people, as a whole, are not marrying less than they used to do; what is wrong is postponement or avoidance of marriage among the more individuated. Not only so, but when they marry they do not have enough children. They do not want to, and the reasons for this are not wholly selfish. A careful analysis is submitted, and attention is directed to the desirability of certain educational and economic changes which may counteract the tendency to race-suicide. There is a point here that seems to be often overlooked in regard to eugenic education. The authors say: "Perhaps the time is not so far distant when babies will be considered an integral part of a girl's curriculum." But while that may be very useful for the girls who marry, is it not apt to be a refined cruelty towards the many who find no mates?

The authors go on to discuss, in relation to eugenics, such subjects as the colour line, immigration, and war—all with the objectivity, scholarship, and fair-mindedness that are characteristic of the whole book. There is a useful chapter on the value of genealogical outlook, both ethically and scientifically. Preoccupation with it may lead to loss of perspective; but to call genealogy a fad is a betrayal of foolishness and vulgarity. The authors' studies end with an emphasis on good environment (euthenics), and this corrects what seems to us a slight partiality in the early chapters. We strongly recommend the book as an all-round, well-documented, level-headed answer to the question: What is practicable in the way of eugenics?

The First Great Alpine Traveller.

The Life of Horace Bénédict de Saussure. By D. W. Freshfield, with the collaboration of H. F. Montagnier. Pp. xii + 479. (London: Edward Arnold, 1920.) Price 25*s*. net.

A LIFE of de Saussure, author of the "Voyages dans les Alpes," has long been desired, and that has now been supplied by an Englishman singularly fitted for the task, Dr. Douglas Freshfield, who was incited so long ago as 1875 by Ruskin, and has been ever since, directly or indirectly, gathering materials. The handsome volume before us is the result. No one has a better knowledge of mountains than Dr. Freshfield, for when a boy, in 1859 and 1860, he accompanied his father and mother on riding tours through several parts of the Alps, and has repeatedly returned thither. He has also explored many other mountain chains, and has published his experiences. In 1869 he described a journey through the Central Caucasus and Bashan, in the course of which he ascended Kasbek and one of the twin summits of Elbruz. In 1896 he published his splendid work on "The Exploration of the Caucasus," and his journey of 1899 "Round Kangchenjunga" was yet more adventurous, though rendered rather less successful by persistently bad weather; while since then, in "Hannibal Once More," he has discussed the route of the Carthaginian general across the Alps, suggesting one considerably south of those generally supported, for which there is undoubtedly much to be said.

Horace Bénédict de Saussure, born at Geneva in 1740, was a man of good family, strong intellect, and remarkably wide education. He could write with ease both Latin and Greek; in addition to French, he knew German, Dutch, and English well enough to converse easily with the educated men of each country, and had a wide knowledge for that day of mathematics, metaphysics, and natural science, especially geology, mineralogy, and chemical physics. In his youth, though the summit of Mont Blanc was visible from the quay of Geneva, very few travellers had penetrated so far as Chamonix until, in 1742, an English party proved that the glaciers of Savoy more than rivalled those of Grindelwald, already known through Scheuchzer's "Itinera Alpina."

De Saussure married early, and as his wife added to his means he was able to gratify his love for travel. Though at times suffering from dyspepsia, he had a strong constitution, and was for more than ten years after 1774 able to lead, with but one interruption, "a life of various activity as a hard-working professor, a man of science, a citizen, and a mountain traveller." In this time he made his principal Alpine explorations, which culminated in 1787–88 and 1789 in the ascent of Mont Blanc, the stay for thirteen days on the Col du Géant, and the tour of Monte Rosa. But evil times were approaching, for the Revolution in France soon found its imitators at Geneva. De Saussure's sense of duty drew him into politics in the vain hope of averting their evils, with the result that he was impoverished and his life more than once in peril. Dr. Freshfield gives us the pitiful story in all its details until in 1794 de Saussure had a stroke of paralysis which, though his brain remained clear and he was able to write two volumes of his "Voyages" and to seek alleviation by visiting baths, ultimately proved fatal on January 22, 1799.

Dr. Freshfield has spared no pains in accomplishing his task, which has evidently been to him a labour of love. De Saussure was the great forerunner of scientific Alpine exploration—a man better qualified than any successor until the days of Principal J. D. Forbes. The latter corrected some of the mistakes into which his illustrious predecessor had fallen, and put the question of glacier motion on a surer footing, about the year 1843, in his "Travels through the Alps of Savoy and other Parts of the Pennine Chain." This gave an increasing stimulus to Alpine travel, which culminated in the foundation of the Alpine Club in 1857, since which date scientific investigation of the Alps and the conquest of mountain difficulties have made wonderful progress. It is scarcely more than 120 years since de Saussure died, yet the pictures representing him on his greatest glacier excursion, and some of his geological speculations, seem to us strangely antiquated. Nevertheless they show him to have been a man of true courage and of a really scientific mind; and this reference to pictures reminds us that Dr. Freshfield has added to the value of his work by a number of well-selected illustrations, among which are not only excellent portraits of de Saussure and of some of his relations and friends, but also representations of places of interest in his history.

T. G. BONNEY.

X-Ray Analysis and Mineralogy.

Lehrbuch der Mineralogie. By Prof. P. Niggli. Pp. xii+694. (Berlin: Gebrüder Borntraeger, 1920.) Price 80 marks.

THIS book, written by the professor of mineralogy and petrography at the University and "Technischen Hochschule" of Zurich, but published in Berlin, is a comprehensive work of some originality. It is illustrated by a large number of figures, which are practically all reproductions of drawings made by the university artist from material supplied by the author. The result is doubtless effective from the author's point of view and for rapid production, but the illustrations are much coarser than would satisfy an average author or publisher in this country, especially in the case of so large and expensive a book.

The work possesses a particular value, however, as being that of a colleague of Prof. Laue, who was called from Munich, after his discovery of the diffraction of X-rays by the planes of atoms in crystals, to become professor of physics at Zurich University, and this fact is revealed by the constant references to the analysis of crystals by X-rays. Indeed, it must prove somewhat embarrassing and bewildering to a student who is not of some years' standing in scientific study to find in the first few pages statements which really embody the complex results of the most recent research—on the structure of the atom, or on the screw-structure of certain point-systems, for instance—alongside the most elementary treatment of the properties of crystals. It amounts more or less to the revelation of their innermost point-system and space-lattice structure before even the obvious characters and attributes of crystals have been touched upon.

The book is, indeed, in its general character, very like a collection of notes for lectures, illustrated by wall diagrams, only very rarely going into any detail with the subject in hand at the moment. Even the names of original authorities, when mentioned at all, are only given as an afterthought in brackets, or in an occasional note in small print, while references to published memoirs are entirely absent. However, a list of textbooks and works of reference is given at the end of the book. The lecture-room impression is still further emphasised by the large amount of tabular matter in the book. Thus the historic sequence of the acquirement of our knowledge of crystals is practically ignored, and information of all kinds—old and new, some easy of comprehension and some quite beyond the understanding of all but those well versed in the elements of the subject—is laid indiscriminately before the reader.

Having said this much, and being forewarned as to these limitations, it is indisputable that the book has many good points, chief of which is that it will be of considerable use to mineralogists, and especially to those of a petrological bent; for chemical crystallography is largely ignored, except as it concerns naturally occurring crystallised substances. Next must come the valuable fact that the book is not only written under the influence of the knowledge acquired during the last seven years by means of X-ray analysis, but also inspired by the presence in the same university of the discoverer of this remarkable method of probing crystal structure. It is also noticeable that certain sections of the book are specially good, chiefly from their novel mode of presentation and illustration. The four pages of drawings of crystals showing their optical properties are of a very original character, and if one were not reminded so forcibly of the wall diagram by their grouping in such closely compacted numbers, the effect would have been more pleasing and the result more striking.

Doubtless the main use for the book will be as an aid to the author's own students, in affording an authentic account of their professor's lectures. The book covers an immense amount of ground, but is, in the main, elementary and superficial, besides being crudely and cheaply illustrated. It is largely redeemed, however, by the many references to X-ray results and by its occasional bursts of originality. A. E. H. T.

Our Bookshelf.

Penrose's Annual. Vol. xxiii. of The Process Year Book and Review of the Graphic Arts, 1921. Edited by William Gamble. Pp. xii + 88 + plates. (London: Percy Lund, Humphries, and Co., Ltd.; Bradford: The Country Press, 1921.) Price 10*s*. 6*d*. net.

This is the second issue after the war, and there is evidence that the editor has now been able to resume the high level of quality that he had attained before the publication of these instructive annuals was interrupted by the exigencies of military service. The volume may not be quite so thick as, but it seems to us superior to, last year's in many ways, especially in the quality and variety of its specimens of reproduction. The editor, in his summing up of the year's progress, finds no striking new departure to record, though there is much evidence of progress in many directions. The activity during the year has been rather in laying foundations that may well be expected to lead to future advances than in the realisation of improvements. Rotary photogravure holds its own, and is doubtless firmly established, as in the *Times Weekly Edition Illustrated Supplement*, but it appears that the production of the cylinders cannot be ensured within the short time necessary to enable a daily newspaper to be produced entirely by this process. The shortage of skilled labour in the process trade is becoming acute.

Among the several interesting and useful articles is a contribution from Prof. Namias, who finds that bichromated papers (as carbon tissue) may be impregnated with the chromate, and yet remain stable for a very considerable time, if not indefinitely, by using a neutral chromate with a small quantity of an alkali, preferably caustic potash. Such paper does not spontaneously deteriorate. To prepare it for use, the sheets may be hung in a box in which is a small dish containing acetic acid for about half an hour. Obviously other methods of acidification may be adopted. Dr. Reginald S. Clay suggests a method of photography in colour by means of a series of interference units (Newton's rings).

The New Hazell Annual and Almanack for the Year 1921. By Dr. T. A. Ingram. Thirty-sixth year of issue. Pp. lvi + 823. (London: Henry Frowde, Hodder and Stoughton, 1921.) Price 7*s*. 6*d*. net.

We are always glad to see this useful annual, which is invaluable for reference in many matters. The volume gives the "most recent and authoritative information concerning the British Empire, the nations of the world, and all the important topics of the day." It contains among other details, including interesting astronomical and meteorological data, a useful list of all the scientific and other societies in the United Kingdom, and the names of the holders of the various Nobel prizes from the date of their foundation. There are also many valuable articles dealing with such diverse subjects as the statistics of education in the British Isles and the present state of aviation. A wide field is surveyed, and the positions of all the outstanding points are recorded.

Das Schmerzproblem. By Prof. A. Goldscheider. Pp. iv + 91. (Berlin: Julius Springer, 1920.) Price 10 marks.

In this little monograph Prof. Goldscheider, whose earlier researches into cutaneous sense physiology are well known, criticises the evidence relied upon by v. Frey to establish the specificity of the peripheral basis of cutaneous pain. The following sentence expresses sufficiently the author's point of view: "The sensation of pain, therefore, owes its existence to a heightening of irritability produced by the stimulus; unlike other sensations, it is not the simple expression of an excitation due to a peripheral stimulus, but presupposes an increased tonus of the sensory nerve-cell in comparison with the physiological condition" (p. 89).

Many of Prof. Goldscheider's criticisms are interesting, but the value of his book as a contribution to psycho-physiology is greatly diminished by his failure to take account of the recent researches of Dr. Henry Head and the latter's colleagues.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Flint Implements from the Cromer Forest Bed.

THE discovery to which this letter relates was made towards the end of September of last year. For the past eighteen months I have spent a considerable amount of time investigating the deposits forming the cliffs of the north-east coast of Norfolk, and have already published a paper dealing with certain humanly fashioned flints found at, and in the neighbourhood of, Mundesley (Proc. Prehis. Soc. E. Anglia, vol. iii., part ii., pp. 219–43). I devoted my attention during last year to the district of Cromer, and have now to record the discovery of a flint-workshop site, which, in my opinion, is referable to the lowermost division of the Pliocene Forest Bed series. As is well known, the Cromer Forest Bed is generally regarded as of Newer Pliocene age, and was laid down after the deposition of the marine Weybourn Crag (latest beds of the Norwich Crag), and before the commencement of the great Pleistocene glaciations. In the Geological Survey memoir, "The Pliocene Deposits of Britain," Mr. Clement Reid states: "Where most complete, the 'Forest Bed' consists of three divisions—an Upper and a Lower Fresh-water Bed and an intermediate estuarine deposit." In many places along the coast the upper portion of the Cromer Forest Bed series can be seen in section towards the base of the cliff, but the lower part, being covered by beach material, can seldom be observed except when a succession of north-westerly gales has caused the sea to scour away the sand and shingle. It is now, however, possible at low water to examine the basal portion of the Cromer Forest Bed deposits when the receding tide has laid bare certain areas which only a comparatively short time ago were covered by great masses of Glacial and other strata in the then existing cliff. The site at Cromer where the humanly fashioned flints dealt with in this letter were found covers an area of foreshore about 150 yards long by 100 yards wide, and is almost opposite the north-western termination of the sea-wall at that place.

The implementiferous horizon is exposed at low water beyond the seaward extension of the shingle beach, and consists of a great number of flints of varying sizes which, for the most part, appear by their coloration and condition to be referable to the well-known Stone Bed occurring beneath the Crag deposits of Norfolk. Associated with these Stone Bed flints are (*a*) examples of paramoudras, (*b*) a few quartzite pebbles, (*c*) very numerous specimens of clay-ironstone pebbles and rolled pieces of chalk (the flint bed in several places rests upon solid stratified chalk which often shows *Pholas* borings in its surface), and (*d*) small pieces of mineralised bone (Mr. Savin, of Cromer, informs me that two molar teeth of *Elephas meridionalis* have been recovered from this site), belemnites, and other chalk fossils. Lastly, there are to be found scattered about amongst these relics numerous examples of humanly fashioned flint flakes and implements which generally exhibit upon their flaked surfaces a brilliant and arresting yellow-ochreous coloration. It is to be remarked also that many of the large blocks of Stone Bed flint show upon their surfaces flake-scars which are of the same ochreous shade, and the conclusion is drawn that these large flint masses represent the cores from which the ancient Cromerians obtained the raw material used in the manufacture of their artefacts. The position of the workshop site at Cromer is indicated in Fig. 1, which gives a diagrammatic cross-section of the cliff, beach, and foreshore.

The association upon the limited area of foreshore mentioned above of cores, flakes, and implements of varying sizes would appear to preclude the possibility of these specimens having drifted down the coast from some other site, as the sorting action of the tides would militate against such an association. Moreover, many of the Cromer flints collected do not exhibit marked signs of rolling by water. But the strongest evidence in support of the view that the specimens secured are referable to some period prior

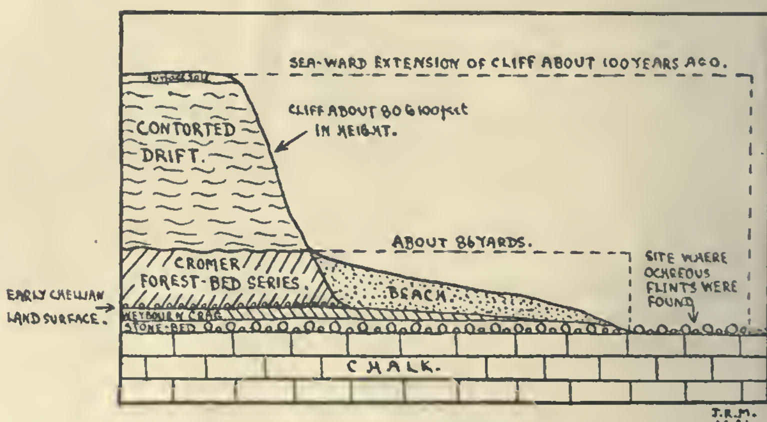

FIG. 1.—Diagrammatic cross-section of cliff, beach, and foreshore at Cromer showing probable relationship of implementiferous horizon to the cliff deposits. (Not drawn to scale.)

to that in which the Glacial deposits forming the Cromer cliffs were laid down is afforded by the fact that the ochreous artefacts have been made almost exclusively from pre-Crag Stone-Bed flints. These latter specimens, often very large and massive, are, to all intents and purposes, sedentary, and have remained so ever since the epoch when they were brought to their present position in pre-Crag times. Thus, when it is realised that many of these large sedentary specimens bear flake-scars exhibiting the same ochreous colour as is to be seen upon the implements and flakes lying near them, it becomes clear that the people who flaked the flints did so at a time when the Stone Bed was exposed, and prior to the deposition of the well-known "Lower Till" and Contorted Drift of Norfolk. And as the coloration of the pre-Crag flints is so markedly different from that of the ochreous specimens, it seems equally clear that the flaking of the latter is not referable to pre-Crag times, but to some later epoch.

I explain these facts in the following manner: After the laying down of the marine Weybourn Crag an emergence of the land took place, and in course of time the Crag suffered considerable erosion. This erosion in places laid bare the sub-Crag Stone Bed, and it would seem that the land surface then existing was inhabited by the makers of the ochreous specimens, who proceeded to use the large, sound pre-Crag flints in implement-making. In support of these conclusions it may be mentioned that in "The Pliocene Deposits of Britain" (p. 40) Mr. Clement Reid states: "There seem never to be more than a few feet of Crag beneath the Forest Bed." Again (p. 149) he states: "It is not improbable that there may also be another land surface beneath the *Lower* Fresh-water Bed, for in one place the Weybourn Crag below the Forest Bed has a rather weathered appearance; but of this one cannot be certain." Further (p. 151) it is stated: "The making of trial borings in 1886 and 1888 showed that the eroded surface beneath the deposit [the Forest Bed] was one of the most marked features, and that there was always a more or less gravelly base to the Forest Bed, beneath which the Crag was cut into by numerous channels or hollows."

As patches of Weybourn Crag are still to be seen near the workshop site at Cromer, and as a very careful search has failed to discover any flints of the same order and colour either in the Stone Bed, where it is exposed at West Runton and Sheringham, or in the upper strata of the Cromer Forest Bed series, it is concluded that the ochreous specimens now described are referable to the earliest member of this series, and are represented elsewhere, in all probability, by the "gravelly base" mentioned by Mr. Clement Reid. I have been able to ascertain that the Stone Bed extends for some distance underneath the shingle beach, and, if excavations could be made, would no doubt be found to occur under the cliff itself. The seaward termination of the shingle beach, where the Stone Bed outcrops, is about 86 yards from the foot of the cliff, and it can be regarded as in every way probable that the workshop site, at present exposed, was covered by the cliff one hundred years ago. In fact, the rate of recession of the cliffs to the south-east of Cromer is much in excess of that allowed for in this estimate. All the above conclusions regarding the geological age of the workshop site and the recession of the cliff at this part of the coast are shown diagrammatically in Fig. 1. It would appear that the sea is gradually uncovering and removing many of the ochreous implements and flakes, as to the south-east of Cromer a number of such specimens may be found upon the shore. These examples exhibit marked signs of rolling and the effects of what is known as "beach action."

The first discovery of flaked flints, claimed as being of human origin, in the Cromer Forest Bed was made by Mr. W. J. Lewis Abbott, who published his original paper in *Natural Science* in 1897 (vol. x., p. 89). I have seen Mr. Abbott's specimens, which are of quite a different order from those with which this letter deals. The number of flints recovered from the workshop site at Cromer now amounts to 249, and they comprise cores, half-finished and complete implements of Early Palæolithic Chellean forms, rostro-carinates, choppers, flake implements, racloirs or side scrapers, points, scrapers of ordinary type, and simple flakes. The majority of the specimens are of massive size, and indicate that the people who shaped them were capable of delivering flake-removing blows of great accuracy and strength. One very large artefact, weighing 7 lb. 6 oz., is flaked into the form of a massive rostrate implement, and, if not used in both hands, could have been wielded only by an individual possessed of great strength and size of hand. The occurrence of several examples at the Cromer site of implements exhibiting flaking upon two opposite surfaces, which approximate in their form to the earliest Chellean artefacts, leads me to regard the whole assemblage of ochreous flints as referable to this cultural stage.

The presence of such an industry in a stratum of, apparently, Upper Pliocene age would seem to be of some interest and importance, and I hope to exhibit the Cromer flints, and to describe them in detail, in the near future.

J. REID MOIR.

Ipswich, January 20.

MR. REID MOIR has submitted sixty of the yellow-stained worked flints from beneath the Forest Bed of the Cromer shore to me, and has asked me to add a few words to his brief report. They are a most impressive collection on account of their abundance, frequently large size, and uniform lustrous surface and orange-brown colour. I have no doubt of their having been shaped by man. Very usually one surface of the flint is a flat orange-brown area produced by a single blow. Others show flaking on both upper and lower surface. Later marginal chipping—subsequent to the ochreous staining of the flint—appears as blue-grey or as black conchoidal scars. Whilst most of the specimens appear to be eminently fitted for use as rubbers in skin-dressing, some show more complete resemblance to coarsely worked ovate implements of Chellean character, and others are distinctly rostro-carinate. The most remarkable among them is the extraordinarily large and heavy rostrate implement weighing 7 lb. 6 oz. It is 10 in. in length and measures 5 in. in breadth and 4 in. in thickness at the butt-end. This huge implement is most definitely shaped by flaking of undoubted human origin. It is almost free from ochreous-yellow stain. Careful drawings of it of the natural size must be published for the use of archæologists. The whole "find" deserves really accurate illustration by figures giving both the actual size and the natural colour. The cost of such illustration is beyond the resources of our learned societies, but may possibly be met by the generosity of those who have enthusiasm for "prehistorics."

E. RAY LANKESTER.

January 29.

Modern Pass and Honours Degrees.

ALLOW me to express agreement with the article on "Scientific Education in the Metropolis" in NATURE of January 20, p. 653, where you deprecate the premature specialisation of a so-called honours degree under modern regulations, as contrasted with the old plan whereby a pass degree in a great variety of subjects had to be taken before specialisation in one subject was allowed. In the old days all the subjects were compulsory, and the range of knowledge required for Matriculation and for First and Second B.Sc. was quite considerable. A candidate who graduated with credit under those strenuous conditions might fairly be considered educated—to some extent even in the Humanities; and, at any rate, he had a severe training in working at subjects for which he had no special aptitude, but of which he ought not to be ignorant, as well as at those subjects which could be assimilated by him without effort.

I hold that the pass degree system in a modern university, if of a proper standard, as it was and I hope still is at the University of Birmingham, for instance, is generally of far more value to candidates and more helpful to their future development than a narrowly specialised course, which is so much easier. A man is engaged on his own specialty more or less all his life, but unless he gains access to the outlying districts of knowledge during his student stage, and under the stimulus of preparation for an examination test, he may never know anything about those other subjects at all.

Reference to an old London University Calendar will show the list of subjects that had individually and separately to be taken and passed in during my own student period—in addition to any attempt to carry some one or more to a higher grade so as to secure specific honours tested by a separate and supplementary additional paper :—

Matriculation.	First B.Sc.	Second B.Sc.
Latin	Mathematics (Trig. and Conics)	Organic Chemistry
Greek	Physics	Physiology
French or German	Inorganic Chemistry	Geology and Palæontology
Arithmetic and Algebra	Zoology	Logic and Moral Philosophy.
Geometry	Botany.	
English Language		
English History and Geography		
Mechanics		
Chemistry.		

Then, on this basis of general knowledge, the doctorate gave an opportunity of carrying some subdivision of one of these subjects to a very much higher stage. Options must be allowed sooner or later, of course, but the question is how soon an option should be allowed. A multitude of options at an early stage is liable to produce a crop of specialists. Such a crop may be necessary for the world's work, but the process of raising it can scarcely be called an education suited to the development of a human being.

While writing, and without presuming to comment on anything concerning London organisation, may I, as an outsider, venture to express a hope that Finsbury Technical College will not be closed? The admirable work done there in the past, and the great names associated with it, entitle it to be held in honour. Let us hope that its benefits will be continued to a generation seemingly more desirous of instruction than ever before. OLIVER LODGE.

January.

Heredity and Biological Terms.

WILL you allow me space for a short comment on the recent discussion in NATURE on Sir Archdall Reid's letters? The chief point raised by Sir Archdall Reid seems to me to be of great importance, and very far from being a side-issue. The usual custom of speaking of "characters" in living beings as either "innate" *or* "acquired": the product of either nature *or* nurture: or of describing them by other pairs of terms of similar import, does lead to much confusion in the minds of many when studying the production of "characters," and very especially that of human characters. Some seventeen years ago, when making a study of this kind, I was aided greatly by many communications I had with Sir Archdall Reid, and particularly by an article entitled "Biological Terms," published in the final number of *Bedrock* in 1914, which virtually sets forth the main position advocated by him in the present discussion. I do not intend to touch on any conflicting views on modes of hereditary transmission which may enter into this discussion, but are not strictly relevant to Sir Archdall Reid's main contention, except to say that the particular difficulty which he points out and strives to conquer can concern only those biologists who do not regard the modern Lamarckian hypothesis as established, or even as verisimilar. If that hypothesis were verified the whole contention would fail.

Sir Archdall Reid's chief point is that it would be a great benefit to science if all branches of it which deal with life adopted a like classification of "characters." At present biologists generally classify characters as "innate" *or* "acquired," while physiologists tend to classify characters from the point of view of the influences, or "nurture," which produce them. He takes, for instance, the case of a hand, a sixth digit on it, and a scar on it. The physiologist says all these characters are products of some kind of nurture, and tries to find out what kind it is. That is the physiologist's business. The biologist, concerned mainly with "nature," says the hand and the sixth digit are "innate" and the scar "acquired." In a certain sense both are right. But the physiologist's language implies that all "characters" are both inborn and acquired, while the biologist's implies that some are "inborn" and some "acquired." The language of the physiologists is always clear, while that of the biologists is very often obscure. Hence, probably, the absence among physiologists of the great divergences of opinion which exist among biologists.

Physiologists are mainly concerned with the development of the individual; biologists with heritage and evolution (or change in the heritage). Assuming that most biologists of the present day hold that heritage passes down the germ-tract, may it not be argued justly that if the child has a hand like the parent, there is no change in "nature" or "nurture"; that if the child has a sixth digit which the parent had not, there is a change in nature, or heritage, but none in "nurture"; and that if the child has a scar, there is no change in heritage, but only one in nurture? It therefore appears to me that Sir Archdall Reid's chief contention is very soundly based. If we think of a hand, scar, and sixth digit as "*characters*," as the physiologist does, they are all alike products of nature and nurture (innate and acquired); if we think of them as *likenesses and differences between individuals*, the hand indicates an innate likeness, the digit an innate difference, and the scar an acquired difference; and if we think of them in *terms of the germ-plasm*, the hand and the scar indicate no change, but the digit is a change (or, in biological language, a "variation").

The burden of Sir Archdall Reid's complaint is that biologists have thought and expressed themselves in terms of "characters," not of the germ-plasm; and that this has largely caused the misleading question, widespread beyond all scientific borders, as to whether "nature" or "nurture" is the stronger influence. This is especially notable in relation to the production of "characters" in the higher animals, and most of all to that of the most distinctive characters of man. Sir Archdall Reid thus insists that a vague terminology has caused neglect of the evolution of the power of developing in response to functional activity; and that, with a more precise terminology, the simple statement, "*Variations are the sole cause of non-inheritance; apart from variations, like exactly begets like when parent and child develop under like conditions*," will cover almost the whole field and thus leave biology free to deal with the many problems of immense scientific and practical importance which concern it.

In my own inquiries I have found that the common assumption of human characters being rigidly divisible as to their origin into two groups, "innate" *or* "acquired," constitutional *or* environmental, is a cause of much confusion; and I think that the import of Sir Archdall Reid's exposition of this matter has not been accorded adequate attention or weight. Nor, after studying the discussion of it in NATURE, can I see any material difference between the views of Sir Ray Lankester and those of Sir Archdall Reid.

H. BRYAN DONKIN.

London, February 1.

The Scientific Glassware Industry.

I HAVE read with very great interest the article on the optical glass industry published in NATURE of January 20, and should like to direct attention to the condition of the scientific and illuminating branches of the glass industry, which are in the same position as the optical section and of equal importance to the nation. The manufacture of scientific glassware, practically non-existent in the country prior to 1914, was undertaken by several glass-makers at the urgent request of the Government, which, shortly after the outbreak of hostilities, discovered that the prosecution of the war was in danger of being impeded owing to the lack of supplies of these articles. The progress made in the manufacture of this apparatus has been very remarkable, especially when taking into consideration the comparatively short time it has been in existence in this country and the great difficulties with which the manufacturers had to contend. The latter have, however, succeeded in producing glass which is in many cases superior to German or Austrian pre-war glass, although it is freely admitted that in the early days the glass produced was in some cases of extremely bad quality. This has now been remedied, and one may fairly claim that, as regards both the quality of the glass and the technique and workmanship, British-made scientific apparatus now is among the best that can be produced anywhere.

The industry is, however, in grave danger of being again completely lost to this country. Owing to prevailing conditions Germany, Austria, and Czecho-Slovakia are trading under conditions which make it impossible for British manufacturers to compete, and the factories have no alternative but to cease work almost immediately unless the Government gives some very definite assurance that the promises it made when it asked the manufacturers to undertake this work will be very shortly redeemed. The industry has not been in existence sufficiently long to enable the manufacturers to create reserves to fight and meet this competition in the ordinary way. On the contrary, the present loss to those engaged in the industry is extremely large, and it is mainly for this reason that they cannot continue production without the assistance of the Government, the most suitable form of which would be legislation on the lines of the Dyes Bill. The large majority of users of industrial and scientific apparatus have considered this question, and have joined with the manufacturers in urging upon the Government the necessity for immediate action in order that they shall not again have to rely upon foreign countries—and possible future enemies—for supplies of glass which is so vital, not only to the scientific and industrial worlds, but also to the very defence of the nation.

T. LESTER SWAIN.

The British Chemical Ware Manufacturers' Association, Ltd., 51 Lincoln's Inn Fields, London, W.C.2, January 31.

Greenland in Europe.

WITH reference to the letter by "T. R. R. S." in NATURE of January 27, p. 694, I may be allowed to add some explanatory remarks which could not be included in the very condensed synopsis of my Cardiff paper. The map showing Spitsbergen as "Greenland" appears in "An Easy Introduction to the Arts and Sciences," by R. Turner, jun., LL.D., late of Magdalen Hall, Oxford, author of "An Easy Introduction to Geography," etc. The copy cited is the fifteenth edition of that work, and it was issued in 1812 by Longman and other London booksellers. The first edition may be assumed to have been printed about twenty years earlier, with or without that map.

It is difficult for us to determine how far the nomenclature of the 1812 edition was then regarded as old-fashioned. To this very day we call the ocean that stretches from the west coast of Spitsbergen southward to the Arctic Circle "the Greenland Sea." For what length of time that expanse of water has borne that name is an interesting question; at any rate, there is no room for doubting that our seventeenth-century whalers and mariners regarded the Spitsbergen region as specially "Greenland."

As for the passage from Goldsmith's Geography, quoted by "T. R. R. S." as indicating another point of view, he will find, I think, on fuller consideration, that it does not conflict with the map of 1812, because Goldsmith's statement that icebergs or ice-floes "are to be met with on the coasts of Spitzbergen, to the great danger of the shipping employed in the Greenland fishery," clearly implies that the scene of "the Greenland fishery" lay off the western seaboard of Spitsbergen. That the latter name was given in the first place to the mountain peaks is manifest; indeed, an Arctic voyager of 1653 illustrates the different application of the two terms. On his outward voyage towards Vaigatz his ship sighted the distant peaks of "Spitzbergen" to northward, but when a visit was afterwards paid to the great whaling station in that archipelago he speaks of the land as "Greenland." Probably the two names have been used interchangeably for many generations.

DAVID MACRITCHIE.

Edinburgh, January 29.

The Mild Weather.

IN continuation of the letter on the above subject in NATURE of January 20, it may be of interest to give a few facts for the calendar month of January, since high temperatures were so persistent throughout. From the beginning to the end of the month there was a neck-to-neck race for record temperature between the Januarys of 1916 and 1921. The temperature at Greenwich for the civil day as published by the Registrar-General's weekly returns shows the supremacy for warmth to be claimed by January of the present year, when the mean for all the maximum readings was 50·0° F., the minimum 40·8°, and the mean of the mean maximum and minimum 45·4°. For January, 1916, the corresponding means were 50·4°, 40·1°, and 45·3°. There is only a trifling difference between the results for the two Januarys, which are the warmest during the last eighty years. In January, 1916, the days were slightly warmer than in 1921, whilst in January, 1921, the nights were appreciably warmer than in 1916.

The two years 1916 and 1921 are the only instances with the January mean maximum temperature 50° or above, and they are also the only instances with the mean minimum temperature 40° or above. In January, 1916, there were nineteen days with the shade temperature 50° or above, and eighteen such warm days in January, 1921; whilst in 1916 there were three nights with the temperature 45° or above, and in 1921 nine correspondingly warm nights. In both years the mean temperature for January was 7° above the normal.

CHAS. HARDING.

65 Holmewood Gardens, S.W.2, February 4.

The Leader Cable System.

SO far back as 1893 the idea was conceived of using electric signals transmitted through a submarine cable to guide ships past dangerous places. But it was not until Prof. R. B. Owens, of McGill University, began investigating the subject that what is now known as the leader cable system took practical shape. Prof. Owens took out certain patents in 1901–3, and these were later presented to the Admiralty, which has decided to allow anyone who wishes to do so to use them without paying royalty.

When Prof. Owens first began his researches the thermionic-valve amplifier was not in existence, and from lack of this important adjunct to its efficiency the leader cable could not be put to practical use, as the signals originated by it were not strong enough for navigational purposes. The invention of the amplifier enabled this defect to be overcome, with the result that during the war leader cables were employed both by ourselves and by the Germans. Such cables have since been laid at Portsmouth, New York, and Brest.

In all these installations the underlying principle employed is that devised by Prof. Owens, but considerable improvements have been made in the details of the apparatus and in the manner of using it. These advances are mainly the result of work carried out at various Admiralty experimental stations, particularly at Portsmouth, where a cable 17 nautical miles in length has been laid along the eastern approach to the harbour. The working of this cable was demonstrated to the foreign naval attachés recently.

A leader cable system comprises a submarine cable laid in any waters where it is desired to facilitate navigation. The sea end of the cable is earthed, whilst the shore end is taken into a transmitting station and there connected to one terminal of an alternating dynamo, the other terminal of the alternator being connected to earth or the sea. In the cable at the shore station a power-operated signalling key is inserted by means of which the current in the cable can be made or broken so as to transmit through the cable any pre-arranged signals or Morse letter. In order that a ship may be able to locate the cable and follow along it a receiving apparatus is fitted in her, or a portable set may be taken on board by the pilot. This apparatus consists of two coils of wire, one on the port and one on the starboard side, which are connected to an amplifier and telephones on the vessel's bridge through a change-over switch. In the telephones the signals given out by the cable are heard as a sharply pitched musical note.

The electric current in a leader cable is an alternating one, and the actual field distribution arising therefrom is complicated by the fact that the return current appears to be mainly concentrated between the cable and the sea surface. Considering the case of a continuous current in the cable and a return path through sea water in the vicinity of the cable, the resultant magnetic field in the air above the cable will contain circular lines of force due to the constant current in the cable and horizontal lines of force due to the return current in the sea water. Assuming the return current to be distributed uniformly and thus to constitute a sheet of current the magnetic field of which is horizontal and at right angles to the cable, the resultant field will be horizontal directly over the cable, vertical some distance away, and again approximately horizontal, but in the reverse direction, at a considerable distance from the cable.

If instead of a current of constant intensity an alternating current is passed through the cable, electric currents in a direction opposed to those in the cable will be induced in the sea water, and the intensity of these induced currents will be greatest near the cable. Above the surface of the water the lines of force due to these induced currents will be slightly curved to the surface, but the general direction of the field will be opposed to that due to the current in the cable. In the final resultant field the points of inversion are moved towards the cable. With increase in the frequency of alternation the induced currents increase in intensity, and as a result the points of inversion (X and Y, Fig. 1) move closer together as the frequency increases.

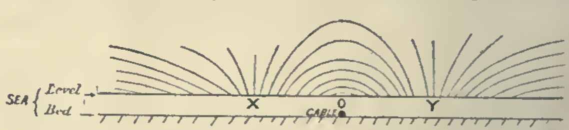

FIG. 1.—Approximate distribution of magnetic field caused by an alternating current in the cable.

When the hull of a ship is brought into the vicinity of the cable that part of the ship—and the space adjacent to it—farthest removed from the cable will be screened to some extent. The ship being a good conductor, electric currents are induced in its outer surface when an alternating current flows through the cable. When the ship is broadside on to the cable these sheets of current flow fore and aft and give rise to a magnetic field parallel to the surface of the ship. If the intensity of the magnetic alternating field giving rise to these induced currents is greater on one side of the ship than on the other, then the resulting magnetic field will be greater on the former side.

When a steel or iron ship lies directly over the cable the intensity of the magnetic field is appreciably increased because of the presence of the ship, but the intensity is small over the deck because of the screening effect of the hull. If on each side of the ship a square frame is placed, and if on these frames a number of turns of wire are wound, thus forming a coil, some of the lines of force will pass through these coils. When the ship lies directly over the cable the number of lines of force passing through each coil will be equal, and the strength of the signals heard in each coil will be equal also. But when the ship is on one side of the cable the strength of the signals received in the coil nearest the cable will be the louder. By this variation in the strength of signals the navigator is able to tell which side of the cable his ship is on.

Experiments made at Portsmouth show that the best position for the coils to be placed is with their centre not farther than within 18 in. from the ship's side and the bottom edges of the coils inclined outward at an angle of 15° to the vertical. When they are so placed screening is satisfactory up to 400 yards, the maximum range is approximately 600 yards, and fairly good signals are obtained even if the cable is approached at a steep angle.

The range at which signals from a leader cable can be received will be largely increased if in place of coils being used two electrodes are towed astern of the ship, these being insulated cables of approximately 50 and 150 yards in length, with the insulation at the outboard ends of the cables stripped back for a distance of 6 ft. so as to make good electrical connection with the sea. The inboard ends of the cables are connected to the receiving apparatus on the bridge through a twin wire led from the stern. The chief difference when using the electrodes instead of coils is that, as with the former there is no screening effect, the signals received do not indicate which side of the leader cable the ship is on. To ascertain this it is necessary to maintain a steady course for some few minutes and to observe whether the strength of the signals increases or decreases.

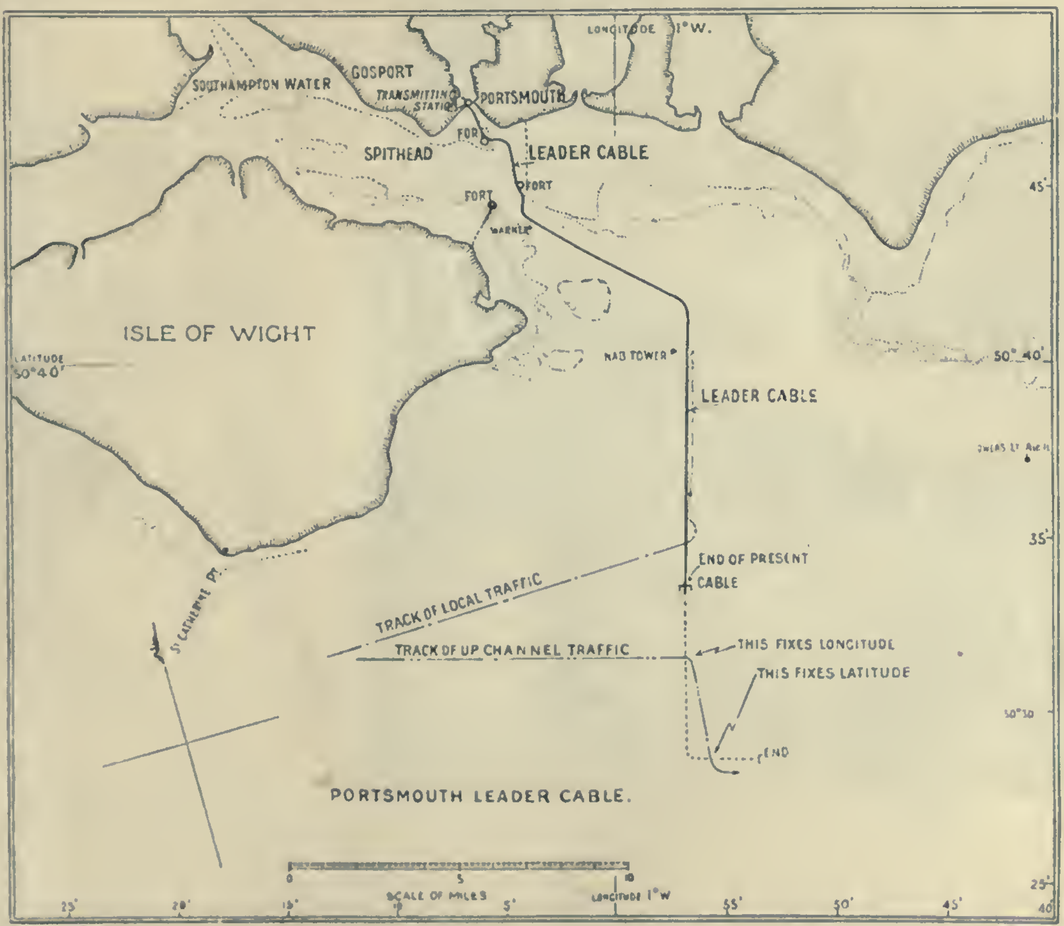

FIG. 2.—Position of Portsmouth leader cable. The broken line turning east from the end of the cable indicates the direction of a proposed extension of the cable which would enable ships proceeding up-Channel to fix their position in thick weather by crossing the cable twice at the points indicated.

In the receiving apparatus aboard ship two leads are taken from each coil to a change-over switch installed on the bridge in such a position that it is easy of access to the navigating officer. Two leads are taken from this switch to an amplifier of the three-valve low-frequency transformer type, using a 4-volt filament battery and a 60-volt anode potential. The telephones are connected directly with the amplifier, and can be fitted with a head-piece or a single receiver. By using a more powerful amplifier it is possible to install a loud-speaking telephone repeater which will enable the signals to be heard by all standing on the bridge. By working the change-over switch the navigating officer is able to detect, from the strength of the signals in the coils, which side of the cable his ship is on, as the signals will manifestly be loudest in the coil nearest to the cable.

The greatest length of leader cable in use is forty miles. For a longer distance than this it would be necessary to pay special attention to decreasing the continuity resistance of the cable and the capacity between the core and earth in order to reduce the current attentuation. This would probably lead to a very expensive cable being required. So far experiments have not been carried out in a greater depth than 30 fathoms, but there is evidence that as the depth of water increases, the strength of signals to one side (say 300 yards) from the cable does not decrease so rapidly as is the case directly over the cable, but the motion of a ship does not materially affect the reception of cable signals by her. It is also possible for a ship to receive visual signals, instead of audible ones, from a leader cable. In that case electric lamps are lighted by the current from the cable. But the visual system has not been developed to such a practically useful stage as the system described above.

Lake Victoria and the Sleeping Sickness.[1]

ONE need not yet have reached extreme old age to remember something of the extraordinary interest excited by the discovery of the great Victoria Lake and the unveiling of the sources of the Nile by Speke and Grant. A wide field for the imagination was opened up by the news of a vast expanse of water, second only to Lake Superior among fresh-water lakes, in the interior of the African continent. Dr. Carpenter's narrative enables us to substitute reality for romance, and to make the acquaintance of a country of great beauty and charm, marred, unfortunately, by the terrible plague of sleeping sickness.

FIG. 1.—Fly beach on Damba Isle; a favourite breeding ground is under the bushes at the gap on the right. From "A Naturalist on Lake Victoria."

The main object of the author in his visit to the great lake was the investigation of the bionomics of *Glossina palpalis*, the tse-tse fly which carries the trypanosome of sleeping sickness. This important work, which was carried on under the auspices of the Tropical Diseases Committee of the Royal Society, involved a residence of about four years on one or other of the numerous islands which stud the northern part of the lake, preceded by a stay of some months at Jinja, on the mainland. The outbreak of war in August, 1914, caused an unfortunate interruption in Dr. Carpenter's labours; for the exigencies of active service kept him employed in various parts of German and Portuguese East Africa until November, 1918, when he was released from duty and returned to Uganda.

In spite of this and other intermissions, the author has been able to put upon record, as Prof. Poulton remarks in his preface, a really wonderful body of observations. The earlier chapters of his work contain a useful *résumé* of our present knowledge of the natural history of *G. palpalis* in its relation to other factors which contribute to the spread of the disease, such as the presence of game. It is needless to say that for the greater part of this now intimate knowledge we are indebted to the admirably devised and painstaking observations and experiments of Dr. Carpenter himself, as may be seen at greater length in the official reports of the Sleeping Sickness Commission. It is satisfactory to know that the author, as a result of his careful study of the habits of the pest, sees some hope, if not of exterminating the fly in certain regions, yet of diminishing its numbers to a point at which it may cease to be dangerous. This, it appears, can be done by constructing artificial shelters which are highly attractive to the fly, and systematically destroying the pupæ that are formed therein. An alternative plan, viz. the extermination of the Situtunga antelope (*Tragelaphus Spekei*), the

[1] "A Naturalist on Lake Victoria: with an Account of Sleeping Sickness and the Tse-Tse Fly." By Dr. G. D. H. Carpenter. Pp. xxiv+333+2 plates. (London: T. Fisher Unwin, Ltd., 1920.) Price 28s. net.

natural reservoir of the trypanosome, is pronounced by Dr. Carpenter to be impracticable.

His descriptions of the sights and sounds of the lake and its islands give a lively idea of the interest of the naturalist's surroundings. "The colouration," he says, "in the bright sunlight during one of the clear days characteristic of the heavy rains is really wonderful in its brilliancy. From high ground one looks over the top of vividly green forest towards distant purple islands set in a sparkling deep blue lake, which is stirred into white-capped waves by the prevailing south-east breeze. So clear is the atmosphere at this time, especially in the evenings, that from Bugalla Island some of the individual houses at Entebbe, on the mainland, twenty-five miles away, could be distinguished with the naked eye."

Some of the voices of the night are thus described: "The thunderous snortings of hippos, the muffled bark of the Situtunga, break in upon the continuous shrill tinkling sound, curiously suggesting sleigh bells, produced by thousands of small frogs along the shore. Crickets chirp all round and in the house, and during the rains one enormous species, sitting just inside the mouth of its burrow, makes the earth resound with a continuous high-pitched buzzing."

The last seven chapters of the book contain a mass of valuable observations on the fauna, especially of the group of islands south of Entebbe, and of the Sesse archipelago in the north-west portion of the lake. The chapters on the insect life are of especial interest, more particularly the minute account of the wonderful mimic, *Pseudacraea eurytus*, in relation to which Dr. Carpenter's criticism of the mutation theory will be read with interest. The book is well illustrated by photographic views and other plates, which are excellently reproduced. F. A. D.

FIG. 2.—The raised beach of Ngamba cleared of vegetation up to the edge of the forest behind. From "A Naturalist on Lake Victoria."

Industrial Research Associations.

IX.—BRITISH BOOT, SHOE, AND ALLIED TRADES RESEARCH ASSOCIATION.

By JOHN BLAKEMAN.

DURING the year 1918 a few prominent Northampton business men felt that it would be advantageous to encourage scientific research in connection with the boot, shoe, and leather industries. The Northampton Boot Manufacturers' Association was approached and promised support, as also did the more prominent leather manufacturers; but at first it was intended that only a local research scheme should be set on foot, conducted jointly by the Northampton boot, shoe, and leather manufacturers. The Research Department was asked for advice, and the secretary, Sir Frank Heath, having attended a conference at Northampton on September 24, 1918, urged strongly that a British Research Association for the boot and shoe industry should be established which should be national in its scope, and should work in co-operation with the Government Department. It was also decided that a separate association should be formed for leather manufacture, but that the Boot and Shoe Research Association should invite leather manufacturers to membership, as they would have many problems in common.

The Northampton Boot Manufacturers' Association promised an annual subscription of 375*l*. for five years, which has been raised by a levy of 7*d*. each on the average number of employees, while the minimum subscription for any firm is three guineas per annum. The council of the Research Association has undertaken that the total contributions from members shall be not less than 500*l*. per annum for five years, and the Research Department will then contribute a sum equal to that contributed by members up to a limit of 1500*l*. per annum.

The association began in Northampton as a local effort, and its organisation has consequently centred round the Northampton Technical School. The work that has been accomplished so far has been made possible only by having the equipment and staff of the technical school available. The organisation, however, is such that if at any time the association develops to such an extent that it would be an advantage to separate from the technical school, this could be done without difficulty. In any case, the work that the association has set before itself can be done efficiently only by national effort, and as interest in the work spreads, the question of the relation of the association to other centres of industry and to educational institutions will have to be reconsidered.

The main objects of the association are:

(1) To establish a reference index for the trade by the systematic collecting, filing, and circularising of information, and the building up of a technological museum.

(2) To establish a scientific laboratory for analysing, testing, and standardising materials used in boot and shoe manufacture.

(3) To investigate the applications of science and scientific methods to the industry.

(4) To investigate suggestions for new materials and processes.

(5) To improve scientific and technological teaching in connection with the industry.

The boot and shoe industry is somewhat peculiar in its character. It does not effect any chemical or physical change in the structure of materials, but simply collects the highly finished products of other industries, assembles them, and converts them into boots. There are a large variety of materials used, the chief one being leather, and little attempt has been made in the past to apply scientific tests to these materials or to standardise them. The materials have to fulfil certain technical conditions, both in manufacture and in wear, and the Research Association will study these materials with the object of expressing their properties in terms of physical and chemical constants, and of seeking the correlation between them and the practical properties required in manufacture and wear.

In the manufacture of boots there are also a very large number of small processes of a highly specialised character, for which a large variety of extremely complex machines are required. The development of these machines comes to-day almost entirely from the engineering side, although they are subject to the criticism of the practical boot and shoe man who operates them. So far there has been little effort to reduce these processes to written descriptions with the object of arriving at an agreement as to the best methods of performing them.

A materials chart and a processes chart have been printed and issued to members (copies of which may be obtained from the secretary, Technical School, Northampton). The objects of these charts are as follows:—

(*a*) To present in a concise form a survey of the problems which may arise in the working of the association, and of the questions on which information may be desired.

(*b*) To form a basis for the systematic filing of information.

(*c*) To secure the co-operation of members of the association in collecting the most useful information.

Specimen entries from these charts are given below:

MATERIALS CHART

Departments			*a.* Standardising	*b.* Chemical analysis	*c.* Testing	*d.* Kinds	*e.* Comparison	*f.* Suitability	*g.* Substitutes	*h.* Cost	*i.* Sources	*k.* Terminology	*l.* Literature
3	Lasts	Measurements											
12	Patterns	Geometrical tools											
24	Clicking	Calf (full chrome)											
37	Clicking	Lineo linings											
55	Closing	Linen threads											
58	Closing	Rubber adhesives											
86	Bottom stock	Insoles											
111	Lasting	Toe hardeners											
126	Attaching	Welting needles											
153	Finishing	Edge trimmer cutters											
187	Cleaning	Patent abrasives											

PROCESSES CHART

Departments			*a.* Methods	*b.* Machines	*c.* Combinations	*d.* Speed	*e.* Quality	*f.* Organisations	*g.* Costing	*h.* Comparisons	*i.* Physical effects	*k.* Terminology	*l.* Literature
3	Patterns	Standard cutting											
26	Clicking	Cutting outsides											
42	Closing	Skiving											
92	Bottom stock	Channelling											
120	Lasting	Pulling over											
131	Attaching	Welt sewing											
170	Finishing	Edge setting											
194	Cleaning	Sizing											

Each square in the charts is intended to suggest a field of investigation—*e.g.* M. 111 *b* would deal with the chemical analysis of toe hardeners, P. 120 *b* with the various machines used for pulling over. The materials chart contains 192, and the processes chart 200, entries.

In the preliminary period to date, the association has investigated problems proposed by members, some minor and some important, and has separated out the problems for immediate investigation. Among those which have been attacked are:—

(1) Analyses of tanning liquors.

(2) Detection of adulterants in linings.

(3) Detection of free acid in insole leathers.

(4) Tensile strength of threads, waxed and unwaxed.

(5) Tensile strength of linings, loops, etc.

The most important of the questions demanding prompt investigation are:—

(1) The suitability of various leathers for welted insoles, the properties required, and the methods of manufacture most likely to yield those results. A special committee is conducting this investigation. A general investigation of sole leathers is to come later.

(2) The cracking of patent leather.

(3) Complete analyses of gums and adhesives used in the industry.

(4) The testing of all threads used in the industry, and the effects of gums and waxes on them.

(5) Finishing of chrome leather soles.

(6) The effects of perspiration on leather.

A large amount of experimental work has been done on the mechanical behaviour of leather under tension, repeated bending to test fatigue effects, and abrasion. Some of these results have been given in a printed paper entitled "Experiments on the Wearing of Bottom Stock Leather under Abrasion," copies of which may be obtained from the secretary at the address given above.

The nature of the problems which are considered likely to be of immediate importance may be illustrated by the questions which have arisen in the work of the special committee on welted insole leather. This committee was set up to consider the properties required in leather to render it satisfactory for welted insoles, to seek the relation between different tannages and the extent to which the desired properties are produced, and to set up a standard for an adulterant-free welted insole.

During the process of manufacture the leather must be such as admits of a satisfactory and durable seam in the process of welt sewing and in wear. It should behave in an ideal manner in its relation to the perspiration from the feet. Most of the English tanners who produce this kind of leather have submitted samples of their products, and these samples are being submitted to the following kinds of tests:—

(1) Wearing tests on hot and dry feet.
(2) Chemical analyses giving percentage of ash, fat, moisture, hide substance, tannin, and water solubles.
(3) Microscopic examination of fibres.
(4) Physical and chemical tests, including tension, abrasion, fatigue on repeated bending, water penetration, drying after wetting, and the tearing strength given by the channel cut in a standard manner.

In conclusion, it must be stated that the Boot and Shoe Research Association has been set up on a very modest scale, with some uncertainty as to the extent to which scientific methods can be applied to the industry. Experience to date has shown that definite and important lines of investigation do exist, and it is hoped that the work of the association will extend.

Obituary.

Dr. J. C. Cain.

Dr. John Cannell Cain, whose death occurred suddenly at his residence in Brondesbury Park on Monday morning, January 31, at the early age of forty-nine, was the eldest son of the Rev. Thomas Cain, of Stubbins, Lancashire, and was born on September 28, 1871, at Edenfield, near Manchester. He received his education at the Victoria University (Owens College) and at the Universities of Tübingen and Heidelberg, obtaining the B.Sc. in the Honours school at Owens in 1892, and the D.Sc. at Tübingen in 1893. It was after he had migrated from Tübingen to Heidelberg in the autumn of 1893 that the writer of this notice first met him. He returned to Owens College for a short time in 1894, where he worked with W. A. Bone, but it is evident that at this period he was already feeling drawn towards that field of organic chemistry to which he ultimately devoted his life, for in 1895 he resisted the lure of research in the rapidly developing organic school at Manchester and entered the works of Messrs. Levinstein, Ltd., of Crumpsal Vale, where he remained until 1901. It was during this period of his career that the writer became intimately acquainted with him, for they lived in the same house at Cheetham Hill, the writer working at research at Owens College, and Cain at Crumpsal. Many were the discussions on colour chemistry which were held during the evenings, and it was here that it was decided to write the book which ultimately appeared under the title of "The Synthetic Dyestuffs" in 1905.

Cain did not, however, remain long at Levinstein's, and in 1901 he became head of the chemistry and physics departments of the Municipal Technical School at Bury, in Lancashire, where he started, with Frank Nicoll, the important series of researches on the rate of decomposition of diazo-compounds, three parts of which were published during 1902 and 1903. At this stage he also commenced his study of the diphenyl compounds, an investigation which, as will be seen, he continued at a later date elsewhere. As an outcome of his research work, Cain obtained the degree of D.Sc. in the University of Manchester in 1904, being one of the first three to receive the highest degree of the newly created University. Nevertheless, his love for the practical side of his science prompted him in 1904 to leave the Bury Technical School and to take up the post of manager and head chemist to Messrs. Brook, Simpson, and Spiller, of London, a position in which he remained until 1906, when he was appointed editor of the Chemical Society's publications, an office he held at his death.

During the period of his editorship Cain spent much of his spare time at research, and in 1907 published his theory of the constitution of the diazo-compounds, an ingenious attempt to harmonise much conflicting evidence, which, although it has not found general acceptance, yet still affords the simplest means of explaining many of the reactions of these very reactive substances. In 1908 Cain published the first edition of his "Chemistry of the Diazo-Compounds," a book which contains a complete account of these valuable substances. Although during this period he was handicapped by the strenuous work required by his office, and to a certain extent by the lack of laboratory accommodation, he was able to continue his research work on the diphenyl compounds, and in conjunction with Miss Micklethwait, Dr. Brady, and others he published three parts of the series. Perhaps one of the most interesting features arising out of this work was the final demonstration that there are two distinct *o*-dinitrobenzidines yielding distinct acetyl derivatives and distinct dinitrodiphenyls, phenomena which, it is suggested, are due to a form of isomerism which depends on the limitation of the free rotation of the singly linked carbon atoms.

During the war Cain placed his services where they were most needed, and as chief chemist to the Dalton Works of British Dyes, Ltd., at Huddersfield, he was responsible for much of the work which has led to the reorganisation of our dye industry. He also, for a short time, acted as superintendent to H.M. factory at Hackney Wick. The services he rendered to the Chemical Warfare Committee were especially valuable, because to him was allotted the task of searching the literature for substances likely to be of a noxious character. This, to the writer's knowledge, he did in no uncertain manner.

During recent years Cain produced a new edition of the "Chemistry of the Diazo-Compounds," a valuable and interesting book on the "Intermediate Products," and a revision of vol. i. of "Roscoe and Schorlemmer." It will be seen, therefore, that Cain was an organic chemist of no mean order, especially in connection with the theory and practice of his favourite subject. That he was an editor who carried out the duties of his editorship with the thoroughness which characterised all his actions the publications of the Chemical Society for fifteen years bear witness; but it will be neither as an organic chemist nor as an editor that he will be remembered best, because he occupied a position alone, in that he possessed a knowledge of chemistry and of chemical data which can only be described as encyclopædic. He was, in fact, a living "Beilstein," and no question seemed to come to him amiss. Woe betide the man who ventured to ignore the previously published work of others, Cain soon pointed out his error to him. The writer can recall an instance in which he had happened to forget a previous paper published by himself on the same subject and to which Cain at once directed his attention.

Cain had an exceedingly lovable disposition. His loss to his friends will be grievous, and to science one which it will be hard to repair.

J. F. T.

CHARLES EDWARD FAGAN, C.B.E., I.S.O.

MR. C. E. FAGAN, secretary of the Natural History Departments of the British Museum, died at his residence in West Kensington on January 30, after an illness which commenced about a month earlier. A short account of the value of his services to the museum was published in NATURE of January 13, p. 638, in a notice of his impending retirement, which was to have taken place on March 31 next.

Mr. Fagan's immediate ancestors were in the Diplomatic Service, and he himself possessed to a remarkable degree qualities which might well have led to high distinction in the same career if he had adopted it. He was born at Naples on Christmas Day, 1855, when his father was Secretary of the Legation in that city. At the age of nine he came to England and was placed under the charge of Sir Anthony Panizzi, being sent to school at Leytonstone. After Sir Anthony's retirement from the post of principal librarian of the British Museum, Mr. Fagan was frequently at his house, where Mr. W. E. Gladstone sometimes joined them in a game of whist. In 1873 he entered the British Museum, and he afterwards followed the natural history collections to the South Kensington branch, where the remainder of his work was done. He became assistant secretary in 1889, and he was appointed secretary of the Natural History Departments in 1919, in special recognition of his services, as a part of the reorganisation consequent on the retirement from the directorship of his contemporary, Sir Lazarus Fletcher, who died on January 6 last.

Mr. Fagan was a man of wide and varied tastes. He had a strong love for natural history; but he was also interested in art, on which he was well informed, and in European history. He could speak with authority of the Napoleonic campaigns, on which he had a good library, and he had also a wide knowledge of the history of the Victorian era. He was joint-author with Mr. Andrew W. Ture of a book on this subject, entitled "The First Year of a Silken Reign." He was interested in every form of sport, and he never missed a University boat race from the year in which he came to London to the last year of his life. His knowledge of the history of English racing was of good service to the museum in the formation of a collection of distinguished racehorses. During the recent war he organised propaganda work, which was important in informing our Allies of the efforts made by this country in the great struggle. In view of his ancestry, which was partly Italian, and of his artistic tastes, it is not surprising that he had a special affection for Italy, which he often visited.

It is impossible to speak too highly of the services Mr. Fagan rendered to the Natural History Museum. Events beginning with Sir William Flower's illness while still director placed important responsibilities in his hands, and the administrative experience thus gained was of the greatest use to Flower's successors in that post, while he worthily upheld the interests of the museum during periods of interregnum. He possessed conspicuous tact and remarkable insight, and he had an extraordinary capacity for forming a correct judgment on a difficult question. These qualities gave him an exceptional position in the museum, and his colleagues who sought his assistance rarely left him without feeling that they had gained by hearing his opinion. The view which he took of the functions of the National Museum was a broad one. Its obvious purposes were to serve as a treasure-house for the accumulation of specimens and to educate students and the general public in all that pertains to natural history. But he thoroughly realised the importance of making it a centre of research, and there can be no question that his initiative was responsible for many new departures which have materially assisted in the advancement of knowledge. In his opinion, an institution supported out of public funds had the responsibility of giving practical service to the nation, and he welcomed opportunities of showing that this could be done. The consultative functions of the museum have been increasingly appreciated in recent years, and particularly during the war, a result largely due to his influence. Its advice has been repeatedly sought by other Government Departments in such matters as the protection of birds and other animals in our Colonial possessions, the part played by insects and arachnids in the spread of disease, and the extraordinary development of the whaling industry during the last fifteen years, in questions relating to fishery problems, and in many other practical applications of zoology, botany, geology, and mineralogy.

On many occasions Mr. Fagan was specially concerned in promoting scientific expeditions, among which may be mentioned those to Ruwenzori, 1907, and to Dutch New Guinea, 1909–11 and 1912–13, the collections in the museum being largely augmented in these ways. By his personal influence he was responsible for inducing private benefactors to present numerous collections and important specimens. He was hon. treasurer to the International Ornithological Congress in 1905 and to the Society for the Promotion of Nature Reserves, British representative on the International Committee for the Protection of Nature in 1913, and a member of the Council of the Royal Geographical Society and of other scientific bodies. He organised the exhibits of the British section of the International Shooting and Field Sports Exhibition, Vienna, 1910, of the Festival of Empire and Imperial Exhibition (game fauna section), Crystal Palace, 1911, and of the British section, Ghent Exhibition, 1913, illustrating the relation of entomology to tropical diseases.

At the age of twenty-one Mr. Fagan married Miss Stronach, who died in 1905, and he leaves one son. His career was one long record of single-minded service, strenuously and successfully performed. His influence on the Natural History Museum, from the commencement of its existence as an independent branch of the British Museum, has left a permanent mark on its character. His disposition was essentially sympathetic, and he never permitted himself to express uncharitable opinions of others. He is deeply mourned by his many friends, and particularly by his colleagues, who recognised his lovable qualities and the great value of his services to the museum and to science.

Sidney F. Harmer.

C. Simmonds.

We regret to announce the death, on January 15, of Mr. Charles Simmonds, one of the Superintending Analysts in the Government Laboratory. Born at Stourbridge in 1861, Mr. Simmonds was educated privately, and, selecting the Civil Service as a career, secured one of the chemical studentships at South Kensington established by the Commissioners of Inland Revenue for training the staff of their laboratory, then at Somerset House. This was afterwards raised to the status of a separate Government Department under Sir Edward Thorpe as the first "Government Chemist." Mr. Simmonds was entrusted (*inter alia*) with the investigation into the composition of "Pottery Glazes and Fritts" for the information of the Royal Commission appointed to report on that subject, and contributed an article under this title to Thorpe's Dictionary of Applied Chemistry, as well as several papers of a kindred nature to the Journal of the Chemical Society, viz. "Lead Silicates in relation to Pottery" (1901); "Constitution of certain Silicates" (1903); "Reduced Silicates" (1904); and (in conjunction with Sir Edward Thorpe) "Influence of Grinding upon the Solubility of Lead in Lead Fritts" (Manchester Memoirs, 1901). Mr. Simmonds was also the author of a treatise on "Alcohol," published by Messrs. Macmillan and Co., which is admittedly the most up-to-date and comprehensive work in English on the subject, and he was up to the last a frequent contributor to the pages of Nature.

Mr. Edward C. Bousfield, whose death is announced, received his professional training at St. Bartholomew's Hospital, and after qualifying spent a number of years in general practice, at the same time carrying out a good deal of research work in microscopy and bacteriology. He was one of the first to take up photomicrography, and published a useful manual on the subject. He afterwards established a clinical research laboratory, and became bacteriologist to the metropolitan boroughs of Camberwell and Hackney.

It was reported from Copenhagen on February 1 that the official Soviet Press Agency had denied the report of the death of Prince Kropotkin, whose obituary notice we published last week. We have been hoping that later messages would confirm this news; but a wireless Press report from Moscow states that Prince Kropotkin died there on Tuesday, February 8.

Notes.

NEXT week's issue of NATURE, February 17, will be a special number devoted to articles upon the principle of relativity. We have been fortunate in securing contributions from leading authorities upon this subject, including Prof. Einstein himself, and the whole number will form the most important presentation of its various scientific aspects yet published. The principle is of such wide significance, and so many books and papers have been written upon it, that a synoptic statement of its structure and consequences will be of permanent value.

THE Actonian prize of the Royal Institution has been awarded to Prof. G. E. Hale, director of the Mount Wilson Solar Observatory, California, for his contributions to solar physics. On Saturday next, February 12, at 3 o'clock, Prof. A. Fowler will begin a course of three lectures at the institution on spectroscopy. The Friday evening discourse on February 11 will be delivered by Dr. F. W. Aston on isotopes and atomic weights, and on February 18 by Mr. Solomon J. Solomon on strategic camouflage.

THE newly incorporated Institute of Physics has issued a pamphlet describing its objects and giving the regulations for the admission of members. The institute proposes to grant diplomas to members indicating a high standard of professional competency, and hopes in this way to secure proper recognition of the professional status of the physicist. It will serve also to co-ordinate the work of existing societies connected with physics and its applications. Any member of a "participating society" is eligible as an ordinary member of the institute, but to become an associate or a fellow he must satisfy certain other conditions which relate generally to his training as a physicist and to the importance of the work in physics in which he has been engaged. The annual subscriptions are: for fellows and associates, two guineas and one guinea respectively, while ordinary members pay no subscription. A member of two or more participating societies pays a reduced subscription to those societies, and under certain conditions the charges for the publications of the societies are reduced. The office of the institute is at 10 Essex Street, W.C.2.

SIR JAMES J. DOBBIE, whose recent retirement from the position of Government Chemist and Principal of the Government Laboratory, held by him since 1909, was referred to last week, has to his credit a considerable amount of research work, particularly relating to the constitution of the alkaloids. He has also devoted much attention, in conjunction with the late Prof. Hartley, to the study of absorption spectra, with special reference to the relation between absorption and chemical constitution, and a large number of papers on these subjects were published in the Transactions of the Chemical Society between 1898 and 1912. Quite recently he contributed papers to the Royal Society (conjointly with Dr. Fox, of the Government Laboratory) on the absorption of light by elements in a state of vapour in relation to their molecular constitution. As Government Chemist Sir James Dobbie has been responsible for numerous important investigations for various Government Departments, such as the nature of the pigments used for postage and other stamps, the properties of celluloid, the preservation of the timber in the roof of Westminster Hall, etc. During the war a large amount of difficult and responsible work was thrown upon the Government Laboratory in connection with the War Trade Department, the analysis of metals and alloys for the Air Board and Admiralty, and the examination of food-supplies for the Expeditionary Forces. Chemical stations were established at the principal supply depôts, and it is acknowledged that the almost total absence of complaints from the Front as to the quality of the food was largely due to the work of the Government Laboratory. Sir James Dobbie is a past-president of the Institute of Chemistry, and is just about to complete his term of office as president of the Chemical Society. We trust that his right to complete enjoyment of his well-earned *otium cum dignitate* may not be long delayed.

A NUMBER of conferences on questions of national interest are announced for the *Daily Mail* Efficiency Exhibition to be held at Olympia on February 10–26. The meetings of the first four days will be devoted to personal efficiency and public health; on February 10 Dr. C. W. Saleeby will speak on child welfare and maternity, and Mr. E. B. Turner, Dr. Latham, and Mr. E. Farmer on industrial fatigue. Sir H. Baldwin, Prof. E. L. Collis, and Mr. F. Watts will discuss preventable diseases on February 11. Both conferences arranged for February 14 will deal with fatigue elimination; the speakers will be Major F. Gilbreth, Mr. Eric Farmer, Dr. H. M. Vernon, and Prof. A. F. Stanley Kent. Fuel efficiency will be discussed on February 17 and 18, when Mr. F. W. Goodenough will deal with coal gas and Capt. R. H. Montgomery with motor fuel. A number of evening medical conferences have also been arranged by the Middlesex Hospital. On February 14, 16, and 23 Dr. W. B. Tuck will speak on the relations between chemical research and medicine, health and pharmacology; and Dr. W. S. Lazarus-Barlow will discuss fluorescence, X-rays, and radium on February 15, 18, and 25. All conferences will be open to visitors to the exhibition, but societies and individuals desirous of taking part in them should apply for special tickets to the Higher Production Council, 66 Victoria Street, London, S.W.1.

MR. L. BOLTON, a senior examiner in the Patent Office, London, has been awarded the prize, amounting to about 1300*l.*, offered by the *Scientific American* for the clearest explanation for general readers of Prof. Einstein's theory of relativity.

AT the annual meeting of the Yorkshire Numismatic Society, held at Leeds University on February 5, the society's first annual medal was presented to Mr. T. Sheppard, curator of the Hull Museums, in recognition of his contributions to the study of numismatics.

A DESTRUCTIVE earthquake occurred on February 4 on the Isthmus of Tehuantepec separating the Gulf of Mexico from the Pacific. According to messages received in the United States from Mexico City, considerable loss of life was caused and much damage to property.

A JOINT meeting of the Faraday Society and the Manchester Literary and Philosophical Society will be held at 36 George Street, Manchester, to-morrow, February 11, at 6.30 p.m. The meeting will be presided over by Sir Henry Miers, president of the Manchester Literary and Philosophical Society, and Prof. A. W. Porter, president of the Faraday Society. The subject to be discussed will be "Measurements of Surface Tension," and it will be opened by Dr. Allan Ferguson.

DR. W. CROOKE discusses certain curious rites at the accession of Rajas in India in the January issue of *Man*. In Vedic times the Raja used to start in his chariot and shoot an arrow at an animal from the herd of one of his relations. Even so recently as 1886, when Madhava Rao Sindhia was invested, the farm was given over to plunder, the sufferers being afterwards compensated at the cost of the State. When a Rajput Raja came to the throne his first duty was to perform the "inaugural foray" by marching against and sacking a town belonging to a neighbouring chief. These are what French anthropologists call *rites de passage*, ceremonies at periods of crisis performed with a magical intent. They represent the period of anarchy occurring between the death of a Raja and the accession of his successor. The new Raja performs an act of bravery or redresses an admitted grievance, such acts being of happy augury for the future reign.

DRS. R. W. HEGNER and G. C. Payne in the *Scientific Monthly* for January (vol. xii., No. 1, p. 47) give a summary of the intestinal protozoa of man in health and disease. They express the hope that the discussion of the subjects presented in this paper will stimulate investigation, and they plead for a carefully organised survey of the intestinal protozoa among civil communities.

WE have received the report of the Research Defence Society for the last quarter of 1920. The society has now been in existence since January, 1908, and its propaganda work has been very valuable in the cause of biological science. The president and treasurers of the International Medical Congress of 1913 have handed over to the society the surplus of the funds of the congress, amounting to some 35*l*. Mr. Stephen Paget is no longer hon. secretary, having been elected vice-chairman of committee, but he will continue writing and advising for the society. Miss Dorothy Burgiss-Brown remains as secretary.

IN connection with the attempt to scale Mount Everest, which is to be made by the Royal Geographical Society and Alpine Club's expedition, it is of interest to learn the views of Col. H. H. Godwin-Austen, whose surveying experiences in Kashmir date back to 1857 and in Bhutan to 1863. Col. Godwin-Austen, in an article in the *Surrey Advertiser* for January 22, expresses the opinion that the best men for the task will be found in the Survey Department of India, and he believes that the number of climbers even in the reconnaissance party projected for the coming summer should be small. He recalls some of his experiences in the first surveys made in Sikkim and the views of Mount Everest which he had from Senchal, near Darjeeling, in 1863. Incidentally, he thinks that the discovery of a route to Mount Everest may not prove a very difficult task.

WE have received from Messrs. W. and A. K. Johnston several sheets of the survey on a scale of 1 : 125,000 of the Gold Coast, prepared under the direction of Major F. G. Guggisberg and engraved and printed in Edinburgh. Each sheet is ½° square, with full reference in the margin to conventional signs and orthography. Hill features are shown by brown shading, but there are no contours; water features and names are in blue, and boundaries in red and brown. The maps are clear and finely engraved, and contain a great deal of information without any crowding or illegibility. The sheets published cover the whole of the Gold Coast, and join in the north the War Office 1 : 250,000 sheets of Ashanti.

Two useful articles on Spitsbergen appear in *Naturen* for September–October, 1920, the publication of the Bergen Museum. Prof. B. J. Birkeland, in writing on the climate, has been at pains to collect most of the meteorological data, some of them previously unpublished, which have been taken at various times. In addition to means of seven years from the Norwegian wireless telegraph station at Green Harbour and Swedish records from Cape Thordsen and Mossel and Treurenberg Bays, Prof. Birkeland gives five years' records from Axel Island, in Bell Sound, three years' from South Cape, and several years' from different stations in Edge and Barents Islands. The South Cape, Edge Island, and Barents Island records, having been made by winter hunters, are in most cases incomplete for the summer months. No data are given from the former Russian station in Horn Sound or from the German station in Cross Bay. The second paper, by Mr. O. Holtedahl, deals with the geology of Spitsbergen and Bear Island, and includes two revised geological sketch-maps, besides several illustrations.

IN 1902 Miss Rathbun, of Washington, described three specimens of a tiny prawn found in the Galapagos and belonging to the crustacean group Caridea. On them she established a new genus Discias, the representative of a new family combining highly specialised characters with others that appear to be primitive. In the Records of the Indian Museum (vol. xix., part 4) Dr. S. Kemp describes a new, but closely related, species from five specimens (male and female) found on a sponge in the Andaman Islands, which are "separated from the Galapagos Islands by almost exactly half the circumference of the globe." A full-page shaded drawing of an "ovigerous female" is reproduced by photogravure—a luxury indicating the importance attached to the discovery; but if Dr.

Kemp was the artist he should have included a scale. Among the many figures in this part of the Records the magnification is given in only four cases.

IN the Proceedings of the United States National Museum (vol. lviii., No. 2344) Messrs. C. P. Alexander and W. L. McAtie deal with the crane-flies and their allies (Tipuloidea) found in the District of Columbia. These insects are prevalent in almost all parts of the world, and they are restricted only by intense cold and dryness. Water or moisture is a necessary condition for the development of most species, and, consequently, deserts form efficient barriers to their dispersal. Among the more interesting features in this paper is a note on the occurrence of the rare and primitive insect *Protoplasa Fitchii*; several larvæ which are referred to this species were found in a decayed drift log, but the adults were not bred out. The winter-gnats (Trichocera) are represented by three species, and the authors follow other recent writers in referring this genus to the Rhyphidæ. The greater part of the paper is devoted to the rich fauna belonging to the family Tipulidæ, which is represented by 40 genera and more than 190 species. The authors include notes on the larval habits of all species wherever known, and they append useful synoptic keys to the various groups along with their genera and species.

PROFS. A. C. SEWARD and B. Sahni have contributed to the Palæontologia Indica (vol. vii., Mem. 1, in Memoirs of the Geological Survey of India, 1920) a memoir entitled "Indian Gondwana Plants: A Revision." The specimens were mostly among those described by Feistmantel, but a revision of the species in the light of modern knowledge had become necessary. The memoir is illustrated by seven fine folio plates, partly photographic, partly from drawings by Mr. T. A. Brock, as well as by a few figures in the text. The senior author was helped in the early stages of his work by Miss Ruth Holden, a young American botanist, whose premature death while on medical service in Russia is a grave loss to science. Prof. Sahni came in at a later period, and hopes to continue work on the same lines in his own country. Two quite distinct floras are dealt with: the Lower Gondwana, of Permo-Carboniferous age, and the Upper Gondwana, which is Jurassic. As regards the former, the authors point out that their results suggest a closer resemblance between the Indian plants and their contemporaries in Europe and North America than had hitherto been realised. For example, the Gondwana genus Nœggerathiopsis is now merged in the familiar Cordaites. The specimens from the Upper Gondwana include several good examples of Williamsonia fructifications, very similar to the well-known European fossils, and to those from Mexico recently described by Dr. Wieland. This illustrates the author's conclusion that the examination of the Indian Jurassic species has revealed additional evidence of the remarkable uniformity of Jurassic floras of widely separated regions. The specimens described in the memoir are impressions, not petrifactions showing the structure, but use has frequently been made of modern methods to bring out such microscopic details, *i.e.* of the epidermis, as can be recognised.

THE Archives of the Cambridge University Forestry Association (No. 4, October, 1920) contains an illustrated article by Mr. H. Stone on the origin of the so-called medullary rays in wood. This paper, which advocates a new theory, contains some information about bird's-eye maple and the cause and nature of the pith-flecks which are so characteristic of birch and certain other woods. The author also discusses the capricious occurrence in the natural orders and in allied genera of the broad compound rays which give rise to "figure" in oak, beech, and plane.

THE Queensland Geological Survey Publication No. 267 (1920) is a description of petrified plant remains from the Queensland Mesozoic and Tertiary formations, by Prof. Birbal Sahni. The series includes two ferns belonging to the genus Osmundites which were previously known only from Jurassic rocks in New Zealand; seven species of gymnospermous woods, six of which are described as new; and three species of angiospermous woods, two of which are new.

THE Norwegian Meteorological Institute has published its Jahrbuch for 1919, containing records of the observations of more than seventy stations. Hourly records are given for Kristiania and Aas, daily means for twelve stations between Mandal in the south and Vardö in the north, and monthly means for the other stations. An appendix gives the observations at Green Harbour, Spitsbergen, for the year 1918–19. The institute has also published "Nedböriagttagelser i Norge," giving the precipitation records for 1919 for 491 stations and a large-scale coloured map showing the distribution of the year's precipitation.

DR. MURRAY STUART'S final report on the Srimangal earthquake of July 8, 1918, is published in the last part of the Memoirs of the Geological Survey of India (vol. xlvi., 1920, pp. 1–70), the principal results having been already given in a preliminary report (see NATURE for April 3, 1919, p. 91). The new memoir contains full details of the nature of the shock and the damage to property, a discussion of the seismograms at distant observatories, and an account of the changes of level in the central district. The epicentre is situated in the Balisera Valley, 3½ miles south of Srimangal railway station, and the epicentral area (the longer axis of which is directed about west-north-west) is crossed centrally at right angles by the line of levels made in 1911–12 from Silchar to Comilla. During the winter of 1919–20 the levelling along this line was repeated by the trigonometrical survey, and this shows that in the interval no settlement had taken place on the north-east side of the epicentral axis. Nor is there any evidence of disturbance on the other side of the axis until the low range of hills six miles west of Srimangal is crossed, but from this range to a distance of thirty miles from the town a subsidence of from 1½ in. to 9 in. has occurred. It would thus seem that "the earthquake was due to subsidence along the southern side of a normal fault cutting the rocks below the alluvium of the Sylhet district, and situated approximately under the major axis of the epicentral area."

La Nature for January 22 contains an illustrated article by M. Léon Laffitte on the methods which are being used by the French naval authorities to refloat those vessels which were torpedoed during the war and sank in situations which render them dangerous to navigation. Maps are given on which the position and name of each submerged wreck are marked. No numbers are mentioned by the author, but the maps show that at least 200 vessels, many of them near the entrances to the larger ports, were lost. The operations are directed by three captains of the fleet, and in most cases are carried out by the compressed-air method, temporary wooden patches being fixed by divers over the holes made in the sides of the vessel by the torpedoes. It is found possible to carry out this work down to a depth of 180 ft.

In a paper read recently before the Institution of Petroleum Technologists Mr. F. H. Garner, of the Mellon Institute, Pittsburgh, discussed the importance of the carbonisation constant of lubricating oils. This constant is determined by exposing the oil to a definite temperature in an oxidising atmosphere, and then measuring the quantity of asphaltene produced. The carbonisation constant is closely connected with the content of resinous matter in the oil, which may be extracted by utilising the selective adsorption of charcoal for these resins. The Conradson coke test was brought forward as an important means of discriminating between different lubricating oils, and it was shown that this criterion was particularly valuable in connection with internal-combustion engines.

Dr. H. E. Armstrong has a charming address on "Detective Work in the Potbank" in the current issue of the Transactions of the Ceramic Society. He shows that, if rightly interpreted, the story of the "crime" committed when, say, iron rusts, so that a valuable strong metal is changed to a worthless powder, is as exciting in its way as the shilling-shocker detective story. He utilises the discovery of the composition of limestone to give his views on the general principles which obtain in the application of science to the manufacture of pottery in particular and to the industries in general. The title of Dr. Armstrong's address is singularly appropriate, because much of the so-called application of science to the industries is an application of the detective instinct in locating sources of loss.

It appears from the *Procès-Verbaux* of the last meeting of the International Committee of Weights and Measures that it will be proposed at the general conference in September next that the functions of the International Bureau shall no longer be confined to the construction and verification of standards of length and mass, but extended to include other units and standards, as well as the determination of physical constants. In the event of this being agreed to by the countries participating in the metric convention, a commencement will probably be made with electrical units and standards. The conference will also consider a proposition to increase the fixed annual budget of the Bureau from the present figure of 100,000 francs to 250,000 or 300,000 francs. The periodical recomparisons of the iridio-platinum national prototypes of the metre and the kilogram are now in progress at the Bureau, and preliminary observations on four of the metres seem to indicate that all of them have undergone a small diminution of length, of the order of half a micron, since their original verification more than thirty years ago. The investigation of the properties of nickel-steel alloys, which led to the discovery of invar, has been resumed, and it has been found that by the addition of 12 per cent. of chromium to alloys of the invar type a metal ("elinvar") is obtained which exhibits a constant modulus of elasticity throughout a wide range of temperature.

A report has now been issued by the Department of Scientific and Industrial Research giving particulars of the work accomplished by the lubricants and lubrication committee. The report fills 126 pages, and contains a large amount of interesting information. A bibliography has been compiled, to be published separately, containing classified references to every published work or paper on lubricants or lubrication of definite importance; abstracts of a large number of important papers are also given in the bibliography, and a complete translation of Prof. Otto Faust's researches on the increase in the viscosity of certain liquids with pressure appears in the report. Research work has also been carried out on behalf of the committee; complete reports and the results of each individual research are given in appendices to the report. There are also a summary of the existing knowledge of lubrication and recommendations for future research on lubricants and lubrication. The tests on the viscosity of liquids at high pressure are of particular interest; in Mr. Hyde's experiments, carried out at the National Physical Laboratory, it was found that all the oils tested showed a rapid increase in viscosity with pressure, and the increase was much greater for the mineral than for the animal and vegetable oils. Castor (vegetable) and Trotter (animal) gave almost identical results up to about 4 tons per sq. in., but at 8 tons per sq. in. the Castor had increased to 5·5 times and the Trotter to 5 times their atmospheric values. The report can be obtained from His Majesty's Stationery Office, price 2*s.* 6*d.* net, and those interested in this subject are recommended to procure a copy.

We have received from the British Scientific Apparatus Manufacturers, Ltd., 198 rue Saint-Jacques, Paris (5e), a general catalogue (in French) of the instruments and apparatus manufactured by its members. This company was formed in February last with the object of making British scientific products more widely known in foreign countries; it serves generally as an advertising medium and a connecting link between manufacturers at home and consumers abroad. The first action of the company was to establish a showroom in Paris, which is now well stocked with samples. Not only can visitors to the showroom obtain full information regarding the apparatus, but also in most cases facilities are available for the demonstration of the exhibits. Although the showroom has been open for a few months only, the results are most encouraging, and a considerable number of inquiries are being dealt with daily. Paris is found to be essentially suitable for a centre of this sort, as is shown by the fact that the visitors' book already contains names of visitors from thirteen different countries. The general catalogue is divided into nine sections under the following headings;—(1) Chimie, Industries chimiques. (2) Electricité, Industrie électrique. (3) Marine. (4) Aviation, Aérodynamique. (5) Métallurgie, Mécanique de précision, etc. (6) Médecine, Bactériologie, Physiologie, Ophtalmologie, etc. (7) Topographie, Géodésie, Astronomie, Météorologie, Dessin. (8) Physique expérimentale. (9) Photographie, Cinématographie. It will be seen that the range of apparatus covered is very extensive. In connection with their Paris showroom the "B.S.A.M." have formed a reference library of English scientific and technical books which are at the disposal of visitors. The showroom is under the management of Mr. F. C. Dannatt.

DR. NORMAN R. CAMPBELL is bringing out, through Messrs. Methuen and Co., Ltd., a work entitled "What is Science?" the aim of which is to explain what science really is and the kind of satisfaction which may be derived from its study. Two other books in Messrs. Methuen's spring list make an especial appeal to readers of NATURE, viz. "Atomic Theories," by F. H. Loring, and "Biological Chemistry: The Application of Chemistry to Biological Problems," by Prof. H. E. Roaf. The first-named volume is written to give in a concise and simple form an account of all the important theoretical and experimental researches on the atom, its structure, and the arrangement of electrons in atoms, in molecules, and in ions. The second may be regarded as an introduction to the more specialised branches of its subject. It will consist of three sections, dealing respectively with a brief description of the parts of organic and physical chemistry which relate to biological chemistry; the accumulation of energy by plants and the interconversion of carbohydrates, fats, and proteins; and the liberation of energy from the food substances.

Our Astronomical Column.

INTERESTING BINARY STARS.—Mr. J. S. Plaskett investigates, in vol. i., No. 2, of the Publications of the Dominion Astrophysics Observatory, Victoria, B.C., the orbit of the spectroscopic binary U Coronæ. Both spectra are visible, each being of type B3. The following are the elements of the two stars in terms of the sun, the brighter star being placed first:—Radii, 2·90, 4·74; masses, 4·27, 1·63; and densities, 0·175, 0·015. Taking the surface intensity of the bright star to be −2·7 magnitudes, as compared with the sun, of which the absolute magnitude is 4·86, the distance is deduced as 400 parsecs. It is, however, noted that the fainter star, though of the same spectral type, has only one-eighth of the surface brightness; this indicates that the correlation of surface brightness with type is less close than some physicists have assumed.

Two other eclipsing binaries of type B, μ^1 Scorpii and V Puppis, are discussed by Miss A. C. Maury in *Popular Astronomy* for January. The masses come out fairly large in these cases, $(m+m_1)\sin^3 i$ being 16·5 and 33 respectively. These would not be very different from the real masses, for, owing to the occurrence of partial eclipses, i cannot differ very much from 90°. μ^1 Scorpii is stated to be of the β Lyræ type, showing double eclipse and continual variation. Stellar tides are suggested in explanation of part of the change of light, and also of changes in the character of the spectrum.

A famous visual binary, 70 Ophiuchi, is discussed by F. Pavel, of Neubabelsberg, in *Ast. Nach.*, No. 5082. It is shown that the irregularities are explicable on the assumption that the principal star is describing the following small orbit owing to an unseen companion:—$T=1809{\cdot}0$, $a=0{\cdot}033''$, $e=0{\cdot}1$, $\lambda=150°$, $i=0°$, period$=6{\cdot}5$ y. The author then obtains for the orbit of the visual pair:—$T=1895{\cdot}965$, $a=4{\cdot}495''$, $e=0{\cdot}4988$, $\phi=29{\cdot}016°$, $\omega=166{\cdot}648°$, $\Omega=122{\cdot}184°$, $i=58{\cdot}743°$, period$=87{\cdot}710$ y. He obtains 0·36 for the ratio of masses, and 1·06 times the sun for the joint mass of the system on the assumption that the parallax is 0·225″.

THE GREEN RAY OR FLASH.—It has often been noticed when the sun is setting behind a well-defined horizon that the last appearance of the disc is a bright green flash. Various explanations have been put forward, some asserting that it was a case of complementary colour, due to fatigue of the retina. This was negatived by the flash being seen at sunrise. Another view was that the sea-water had something to do with it, but it was found that the effect could also be seen at a distant land horizon. There remained the explanation of atmospheric dispersion; but here again there were diversities of view, some holding that the normal colour dispersion would suffice, others invoking abnormal phenomena of the nature of the mirage.

L'Astronomie for December contains an interesting research by MM. A. Danjon and C. Rougier, of the Strasbourg Observatory. They installed a spectroscope on the roof of Strasbourg Cathedral, and were able to demonstrate that the phenomenon arises from normal dispersion. There is an image of the sun produced in light of each wave-length, and as the sun gets low these images are more and more widely separated. When the sun was a few degrees above the horizon the observers were able to obtain a spectrum showing red only when the slit was at the lower limb, and a spectrum with the red absent when it was at the upper limb. When the altitude is less the blue and violet are altogether absorbed, and the green image of the sun's upper limb is the last visible at sunset. Their horizon was formed by distant low hills, but they point out that a sea horizon may be better in that the presence of the bands of water-vapour helps to separate the red light from the green. The spectra obtained are reproduced in the article, and seem to settle the nature of the phenomenon beyond a doubt.

Applied Entomology.

BULLETIN 805 of the United States Department of Agriculture deals with "Two Leafhoppers Injurious to Apple and Nursery Stock," and gives an account of the apple leafhopper and the rose leafhopper. Of the two species, the apple leafhopper causes the greater damage, and is most prevalent in the eastern States, attacking a large variety of plants, on which it chiefly injures the tender terminal leaves, causing them to turn brown. The rose leafhopper also attacks a large variety of plants, and is especially prevalent in the north-western States. Full accounts of the life-histories and descriptions of the insects in all stages are given, and sprays for controlling them recommended.

Farmers' Bulletin 650 of the United States Department of Agriculture deals with the San José scale, which attacks many species of trees, causing considerable damage to, and sometimes killing, fruit trees. During the summer the scale reproduces exceedingly rapidly, the life-cycle taking thirty-three to forty days, and, although it has a large number of parasites, they are insufficient to act as an effective check. The scale is distributed on nursery stock, etc., and the young are also probably spread by wind, other insects, and birds. The scale can be kept in check by thorough annual spraying when the plants are dormant, lime-sulphur wash being recommended for this purpose.

In Farmers' Bulletin 1061 an account is given of the Harlequin cabbage bug, which occurs in all but the northern States, and is a very bad pest of cabbages and allied plants. Removal of wild crucifers and remains of crops, trap-crops, and hand-picking are effective, and also contact insecticides, but co-operation between neighbouring growers is necessary to control this pest.

Farmers' Bulletin 1086 gives an account of "How Insects Affect the Rice Crop in the United States." The most important pest is the rice water-weevil, the larva of which feeds amongst the roots of the rice plant at the base of the stalk, causing considerable damage to the crop. The stink bug attacks the soft grains of the rice while they are forming. The fall Army worm or Southern grass worm occasionally becomes abundant and damages rice fields in the spring, but is easily destroyed by flooding the fields. The caterpillar of the rice-stalk borer feeds in the stalk and causes the head to die. These pests are controlled by thorough cultivation, by suitable flooding and draining of the fields, and by keeping the fields and banks clear of weeds.

In Farmers' Bulletin 1101 an account is given of "The Argentine Ant as a Household Pest." This ant occurs in scattered localities throughout the South. Owing to its encouraging aphids and scale insects, it causes considerable trouble to fruit-growers and others, while it causes much annoyance by swarming in houses. The ant has been distributed in foodstuffs, and is also carried by floods. Formulæ are given for tree-banding mixtures and for poisons for use in houses and in the open.

Farmers' Bulletin 1104 deals with the book lice or Psocids which frequently occur in houses and other buildings, and may occasionally increase in numbers to such an extent that it is necessary to take steps to destroy them, for which purpose fumigation with sulphur or hydrocyanic acid is recommended.

In the *Journal of Agricultural Research* (vol. xviii., No. 9, 1920) an account is given by J. M. Aldrich of "The European Frit Fly in North America." This pest occurs principally in the regions in which winter wheat is grown, from the Great Lakes to the Ohio River and westward to the Missouri, but it is generally distributed over most of the country. A full description, with figures, is given of the life-history, and also a plate of the adult and puparium. As many as four broods were obtained in the summer, the first, from larvæ which had lived through the winter, in April. Eggs and larvæ are usually found on the young and tender shoots and also sometimes upon or within the glumes, wheat, barley, and various grasses being attacked. It is recommended that wheat should be sown late in the fall or early in the spring in order to escape the attack of this insect.

In the same journal (vol. xix., No. 1, 1920) an account of "The Banana Root Borer," which is a widely distributed pest of the banana, is given by G. F. Moznette. The larvæ of this weevil, *Cosmopolites sordidus*, feed in the roots of the plant, and the damage done to young plants causes them soon to wither and die. Full descriptions of all stages and of the life-history are given in the paper, which is illustrated by four plates. Destruction of infested plants and trapping of adults by means of strips of banana-trunks placed on the ground are advised.

The European corn-borer has recently been introduced into the United States, being first discovered there in 1917, and has already spread over considerable areas in the North-east, and it seems likely to do more damage than any native species (State of Illinois, Department of Registration and Education, Division of Natural History Survey, Bulletin, vol. xiii., art. 10, "The European Corn Borer and some Similar Insects," by W. P. Flint and J. R. Malloch). The larva of this moth, *Pyrausta nubilalis*, Hubner, feeds on all parts of the plant above the ground, many species of plants being attacked, but corn appears to be preferred. An account is given of the life-history of this insect, which may have two broods in the year, the winter being spent as full-grown larvæ which hibernate in the stems of the food plant. This pest is probably chiefly spread in the stems of its plant-host, although, as the moth is a fairly strong flyer, it might also be disseminated in the latter stage. A number of native borers closely resemble the European corn-borer, and descriptions are given to enable it to be distinguished therefrom.

Bulletin, vol. xiii., No. 11, 1920, of the same series is concerned with "A Study of the Malarial Mosquitoes of Southern Illinois. 1. Operations of 1918 and 1919," by S. C. Chandler. An account is given of a survey of the mosquitoes of two districts of Southern Illinois in which malaria occurred frequently, in addition to less thorough work at other points. The breeding areas were examined, and larvæ were most plentiful in fairly clean, still water in which there was vegetation. Two of the species found are capable of transmitting malaria. To get rid of the mosquitoes drainage is the most effective measure. Clearing the edges of the ponds, etc., of vegetation is also suggested, as well as oiling the surface of the water, and the use of larvicides. Houses should be screened or fumigated.

The Department of Agriculture, Ceylon, Bulletin No. 46, by N. K. Jardine, gives an account of "Field Experiments with Anti-Tortrix Fluids." The experiments showed a greater yield from the treated plots than from the control, and the quality of the tea was not lowered. In treating a substance intended for human consumption, such as tea, the use of poisons is not possible, and as contact poisons are useless against the tea tortrix, owing to its rolling itself up in a leaf, it was necessary to find some other substance which would serve the purpose, and lead chromate was found to be very suitable. The formulæ used are given and also the cost of each and of the spraying. Samples from the control and sprayed plots were tested by tea-brokers, and their reports are given, the tea treated with the sprays, especially that containing resin and sodium carbonate, in addition to lead chromate, being generally preferred. Rain was found to have little effect, provided the spray had dried.

Food and its Preservation.[1]

THE work done under the direction of the Food Investigation Board of the Department of Scientific and Industrial Research during the year 1919, although its primary object may be said to have been of a practical nature and mainly devoted to the various means of preserving animal and vegetable food, serves well to show how such an object requires previous investigation of many fundamental and purely scientific problems. On account of the strictures that have been made as to the support of pure science by the Department in question, we may take note that it is pointed out in the report before us that "the application to industry of many of the researches is not immediate, and often not obvious." Such results will be especially referred to in the course of this article, but it is not intended thereby to minimise the value of the practical work of the Board.

With regard to the freezing of meat and fish, a valuable series of researches was undertaken on the phenomena occurring in the freezing and thawing of systems containing colloids and electrolytes, with especial reference to the separation of the constituents of such systems and to the diffusion of salts through their solid phases. Our knowledge of the properties of these systems has been greatly enlarged by this work, and a general report on it is now being prepared. Attention may be particularly directed to the fact that by sufficiently rapid cooling to a temperature which corresponds to the eutectic of a saline solution the separation of frozen water as a visible phase is avoided. Thus, on thawing, the system returns to its original state and the irreversible separation of the colloidal material does not take place, as happens on slow freezing at a temperature only a few degrees below the freezing point of the system.

The conditions of growth of bacteria and moulds were naturally subjects of immediate interest. It is well known that bacteria growing in a particular medium, after a period of multiplication, gradually die off. This is shown by Dr. Graham-Smith, in the report, to be due, not to accumulation of toxic products of their own activity, but to the exhaustion of some specific food material. Bacteria of another species are able to grow in a medium which has previously been exhausted by a different species so far as its own growth is concerned. An interesting fact brought out by researches on the "black-spot" mould (shown to be a species of Cladesporium) is that it will grow at a temperature of -5° C. It is clear that the protoplasm in the cells does not freeze, although the expressed juices of plants usually freeze between -2° and -3° C. No doubt capillary forces are responsible for the lowering of the freezing point in the narrow cells.

The question of the discoloration of fruit led to an investigation on the nature of the enzymes responsible for oxidation in plants. An important fact in relation to the general theory of the mechanism of oxidation was brought out in an examination of linseed oil. It was found that the oil oxidises slowly in air without the presence of any kind of catalyst, although in the oxidation system of the cell there is evidence of the presence of a catalyst accelerating autoxidation. In connection with enzymes the work on pectin production may be mentioned.

Of more strictly chemical interest is the discovery that glycerol can be replaced in fats by mannitol, such fats being similar to the corresponding glycerol esters and behaving in the same way as foods. Other work giving an insight into the chemistry of the production of glycerol itself was also undertaken. Of practical importance for workers with the products of degradation of proteins is the method devised by Mr. Foreman for estimating the simpler products of bacterial decomposition. A curious fact is that the equilibrium position reached in the autolysis of beef is not the same as that in the case of mutton, suggesting that the presence of more than one phase in the heterogeneous system of the cell must be taken into consideration.

The work of the Engineering Committee of the Board, as would be expected, has been mainly industrial, but the systematic investigation of the heat-flow through various materials and the loss of heat by convection from plane surfaces may be referred to here as of general scientific interest.

We may note, finally, that the Board has obtained a grant to build and equip a research station at Cambridge for biochemical and biophysical investigations at low temperatures.

W. M. B.

[1] Department of Scientific and Industrial Research. Report of the Food Investigation Board for the Year 1919. Pp. 36. (London: H.M. Stationery Office.) Price 6*d*. net.

The Older Palæolithic Age in Egypt.

PROF. C. G. SELIGMAN, at a meeting of the Royal Anthropological Institute on January 11, read an important paper on "The Older Palæolithic Age in Egypt," embodying the results of an attempt made in 1914 to secure definite stratigraphical evidence of the antiquity of implements which, if found in Europe, would be classed as Chellean, Acheulean, or Mousterian. The sites visited were Abydos, Thebes, Tel-el-Amarna, Meir, and Wady Sheikh, and a short trip was made to the Fayum. Some areas, however, may be described as flintless; flints of Palæolithic type were very common in the neighbourhood of Thebes and Abydos, but were scarce near Meir and Tel-el-Amarna, and did not include either Chellean or Acheulean types. Wady Sheikh showed no definite Palæolithic types, but specimens of early historic date were valuable for the light they threw on the patination of high desert specimens.

The implements found included hand-axes (Chellean type), hand-axes with borer point (not found in Europe), and finely worked ovates (Acheulean type). The points, side scrapers, borers, hollow scrapers, and tanged points (spear- or arrow-heads) Prof. Seligman grouped together as Mousterian, not because they were specially typical of the Mousterian culture, but for reasons connected with the localities of the finds, stratigraphy, and patination. Also included in the group were two forms not occurring in Europe, namely, "crescents" and a heavy drawing-tool, for which the name "tortoise point" was proposed. Forms transitional to Capsian, or Capsian, were notched flakes, end-scrapers, hollow end-scrapers, nose end-scrapers, end-borers, and asymmetric end-borers. From the morphological point of view the river-drift types were unmistakable, while the Mousterian types, so far as the borers, scrapers, and points were concerned, could be paralleled precisely from European forms, while the non-European forms could either be derived from well-known types or were produced by an identical process. A certain number of implements could not readily be referred to Chellean, Acheulean, or Mousterian technique, and, although they might be classed in Europe as Aurignacian of a coarse type, Prof. Seligman was inclined to regard them as highly developed Mousterian modified by Capsian influence from the north.

The great majority of the implements from the Thebaïd present a more or less lustrous surface of various shades of reddish-brown. Specimens of different shades of dull white occur, but only in wadies and "wash-outs." This marked difference in coloration was undoubtedly due to the fact that the white specimens had only comparatively recently been weathered out of the gravels forming the banks of the wadies.

In reference to the stratigraphical evidence for the age of these implements, Prof. Seligman gave a detailed account of the geological character of the area in which they were found. Implements of a highly developed Mousterian type, without the characteristic brown patina of the palæoliths which have been exposed to weathering, have been found *in situ* in undisturbed gravels of Pleistocene age.

An interesting discussion followed the reading of the paper, in which several points of importance were touched upon. Mr. Reginald Smith argued that while patination was an indication of great age, absence of patination did not indicate the reverse; the oldest types of French cave implements showed no patination. He also asked if Prof. Seligman had been able to correlate relative antiquity of type and shade of patination. In reference to the geological data, he was of the opinion that further evidence was required to establish the Mousterian character of some of the implements, especially in the case of those not collected by Prof. Seligman himself. Mr. M. Burkett briefly reviewed recent French work on this subject, and cited the results of a correlation of type and patina which had recently been made by the Abbé Breuil in a series from Tebessa (Southern Algeria). Mr. H. Peake pointed out that the Mousterian industry appeared to have developed further in Africa than in Europe, where its development had been interrupted by the Aurignacian type, and he suggested that this might be due to more favourable climatic conditions on the former continent. It had been stated that no Sofutrian culture was found in Africa, but in this case it was difficult to account for the resemblance between certain Saharian and the Solutrian implements. Prof. Fleure said that Prof. Seligman's evidence pointed to a continuous development from Mousterian to Capsian; geographical conditions suggested that at this period there was a great difference between the climates of Africa and Europe.

Tides in Small Seas.

TWO important papers on the tides in small seas have recently been published by the Vienna Akademie der Wissenschaften. The first, in Bd. 96 of the *Denkschriften*, is the latest of a series of researches by R. Sterneck, jun., on the tides of the Adriatic; the second, in Bd. 129 of the *Sitzungsberichte*, is the sixth part of A. Defant's researches on tides in "Mittel- und Randmeeren, in Buchten und Kanalen," and concerns the tides of the Irish Sea. Both investigations are applications of hydrodynamical principles, assuming from observation just sufficient to give or replace the "boundary conditions" where the sea communicates with the larger body of water. Both treatments depend on the elongated nature of the sea in question and utilise charts of soundings after the manner initiated by Chrystal for the longitudinal seiches of lakes. Defant makes separate applications to the Bristol Channel, Liverpool Bay, and Solway Firth. In each case the assumed type of motion may be regarded as a longitudinal oscillation sustained by the tides outside, together with a transverse gradient maintained by the longitudinal current in virtue of the earth's rotation.

Sterneck considers separately the four chief semi-diurnal and the three chief diurnal harmonic constituents; Defant considers mainly the semi-diurnal spring tides. In each case the agreement with observation is remarkable. That for the Irish Sea is not so close as that for the Adriatic, but this is to be expected when the deviations from a canal of slowly varying section and the ratio of tidal range to water-depth are taken into account. Friction is neglected altogether by Sterneck for the Adriatic, but is an important element in Defant's explanation of the Irish Sea tides, in which the amount is of the same order as that used by G. I. Taylor. The negligible importance of friction in the Adriatic may be ascribed to its greater depth and much smaller currents as compared with the Irish Sea. Sterneck calculates the longest free period of the Adriatic to be about 23 hours as against the 16 hours of previous calculations by the "Merian" formula. The larger number agrees well with the observed seiches, and shows the possible error of rough methods. Defant estimates the longest free period of the Irish Sea to be about 18 hours.

J. P.

Paris Academy of Sciences: Loutreuil Foundation.

REQUESTS for grants to the amount of 219,600 francs were received by the Academy. Six of these were refused on the ground that they were presented by persons belonging to universities already in receipt of funds from M. Loutreuil. A total sum of 131,200 francs is allocated by the council of the foundation to the following:

I. *Grants to Establishments named by the Founder.*

(1) National Veterinary School of Alfort: 8000 francs for the construction of a special room for researches relating to the therapeutics of cutaneous and respiratory diseases.

(2) National Veterinary School of Lyons: 3200 francs to François Maignon, for the purchase of

instruments and apparatus for his researches on nutrition.

(3) National Veterinary School of Toulouse: 3000 francs to Jean Lafon, for his researches on the comparative physiology of the secretions in different animal species.

II. *Grants to Establishments Called to the Consultative Committee of the Foundation by the President of the Academy.*

(1) Conservatoire national des Arts et Métiers: 6000 francs to Henri Chaumat, for his studies on the electrical and magnetic properties of electrolytic iron.

(2) Central Electrical Laboratory: 10,000 francs for the researches, under the direction of Paul Janet, on the absolute standards of the international ohm.

III. *Grants Given on Personal Application.*

(1) 10,000 francs to Charles Alluaud and to R. Jeannel, for the study of the zoological and botanical material collected by them in the high mountains of eastern Africa and for the publication of the results.

(2) 5000 francs to Jules Baillaud, for the establishment of a recording microphotometer of the type suggested in 1912 by P. Koch.

(3) 3000 francs to Henry Bourget, director of the Marseilles Observatory, for the *Journal des Observateurs*.

(4) 2000 francs to Clément Codron, for his researches on the sawing of metals.

(5) 5000 francs to the School of Anthropology, for the publication of the *Revue d'Anthropologie*.

(6) 4000 francs to Justin Jolly, for the publication of a work on blood and hæmatoporesis.

(7) 7000 francs to Louis Joubin, for the publication of the results of the French Antarctic Expedition.

(8) 3000 francs to the late Jules Laurent, for the publication (under the direction of Gaston Bonnier) of a work on the flora and geography of the neighbourhood of Rheims.

(9) 3000 francs to Henri Brocard and Léon Lemoyne, for the publication of the second and third volumes of their work entitled "Courbes géométriques remarquables planes et gauches."

(10) 2000 francs to A. Menegaux, for the *Revue française d'Ornithologie*.

(11) 5000 francs to Charles Nordmann, for his researches on stellar photometry.

(12) 8000 francs to the Zi-Ka-Wei Observatory, in China (director, R. P. Gauthier), for recording time-signals from distant centres.

(13) 2000 francs to O. Parent, for his studies on a group of Diptera.

(14) 10,000 francs to G. Pruvot and G. Racovitza, directors of the *Archives de Zoologie expérimentale et générale*, for this publication.

(15) 6000 francs to Alcide Railliet, for the publication of researches on the parasites of the domestic animals of Indo-China.

(16) 4000 francs to J. J. Rey, for the publication of a botanical geography of the Central Pyrenees.

(17) 10,000 francs to Maximilien Ringelmann, for researches relating to the physical and mechanical constants of metals intended to be used in the construction of agricultural machines.

(18) 12,000 francs to the Academy of Sciences, for the establishment of a catalogue of scientific and technical periodicals in the libraries of Paris.

It was pointed out by the council in 1917 that, although the special object of this foundation was the promotion of original research, up to that time requests for assisting work to be carried out according to a well-defined scheme had been exceedingly few in number. For the three years 1914–17 the majority of the requests had for their object the establishment or improvement of equipment more suitable for teaching than for personal work. These remarks still apply, and a possible modification in the method of dealing with the revenue of this foundation is foreshadowed.

University and Educational Intelligence.

BIRMINGHAM.—At a special degree congregation held in the Great Hall of the University on Saturday, February 5, the honorary degree of Doctor of Laws was conferred on the Prime Minister, the Right Hon. David Lloyd George, who had a most enthusiastic welcome. After receiving the degree the Prime Minister made a short speech in which he expressed his admiration of the way in which the universities of the country had come to her aid in the great war, and his own surprise at the discovery of the vital importance of the universities, not only as centres of culture and learning, but also as essential factors in the strength of the nation. He paid a generous tribute to the energy and foresight of the founder of the University of Birmingham (Mr. Joseph Chamberlain), and hoped that the Midland area generally, realising its obligation, would come to the assistance of the University in this its time of serious financial need.

On behalf of the subscribers to the Poynting Memorial Fund, the portrait of the late Prof. J. H. Poynting (by Mr. Bernard Munns) has been presented to the University, and Mr. W. Waters Butler has presented the portrait of the late Prof. Adrian Brown by the same artist. The council has expressed its warm appreciation of these gifts, both of which now hang in the Great Hall of the University.

In response to the appeal for 500,000*l.*, the sum of 280,144*l.* has been received or promised.

CAMBRIDGE.—Dr. C. S. Myers, Gonville and Caius College, has been appointed reader in experimental psychology, and Mr. F. A. Potts, Trinity Hall, demonstrator of comparative anatomy.

A grant of 150*l.* from the Craven Fund has been made to the managing committee of the British School at Athens in aid of further excavations at Mycenæ.

A LECTURE on "The Innervation of Striped Muscle Fibres and Langley's Receptive Substance" will be given at the rooms of the Royal Society of Medicine, 1 Wimpole Street, W.1, by Dr. J. Boeke, professor of embryology and histology in the University of Utrecht, at 5 p.m. on Wednesday, February 16. This lecture has been arranged under a scheme for the exchange of lecturers in medicine between England and Holland. Four other Dutch lecturers will also give one lecture each, particulars of which will be announced later. The chair at the lecture of February 16 will be taken by Prof. W. M. Bayliss. Admission is free, without ticket.

THE University of Bristol will shortly possess as fine a block of university buildings as can be found in the United Kingdom outside Oxford and Cambridge. The entire expense of erecting these buildings was, from the outset, undertaken jointly by Mr. George A. Wills and Mr. Henry H. Wills. The cost of completing the work will vastly exceed even the liberal sum contemplated when the gift was originally made. Additional contributions were made by the two brothers during the course of the war, and since the present year commenced they have placed in the hands of the University an additional benefaction of as much as 200,000*l*., hoping to enable the buildings and design to be fully carried out. It is reassuring to note that these two public-spirited citizens are not allowing their munificent gift of 1913 to fail of fulfilment even in the difficult circumstances of the present time.

THE universities in Australia are apparently suffering, like our own institutions, from an inability to make their incomes meet their expenditures under post-war conditions. At Sydney the University authorities have decided to raise the fees in all the various schools, in some cases by as much as 50 per cent., in order to meet the increased cost of materials. Melbourne University has issued an appeal for 100,000*l*., towards which it has obtained only the sum of 30,000*l*., subscribed in small amounts; it hopes to raise a further sum of 20,000*l*. in a similar way, but no large gifts have yet been made. Sir W. H. Irvine, Lieutenant-Governor of Victoria, discussed the situation at Melbourne on January 31, according to a *Times* correspondent, and suggested that wealthy Victorians might well follow the example set by Sir J. Langdon Bonython in South Australia, who has presented the sum of 40,000*l*. to Adelaide University.

WE learn from an article in the *Times Educational Supplement* that the Vice-Chancellor of the University of Madras, Mr. K. Srinivasa Iyengar, who is now a member of the Madras Executive Council, laid great stress on the neglect of science and technology in India in his recent convocation address. The careers of 18,500 graduates of the University had been traced, and of this number about 3700 were engaged in teaching, 765 had taken up medicine, while only 56 had devoted themselves to science; the remaining 14,000 were divided between law and Government administrative service, with a big majority for the former. The Vice-Chancellor concluded his account of the statistics he had accumulated with the words: "You will search in vain for any solid contribution to the sum of human knowledge among the magnificent number." These facts have been appreciated by many leaders of Indian thought, and several of the more wealthy men have endeavoured by their munificence and influence to create a stronger feeling for science. The Indian Institute of Science at Bangalore owes its existence to the late Jamsetji Tata, and some eight years ago the late Sir Taraknath Palit made over money and land of the aggregate value of 15 lakhs of rupees (100,000*l*.) to the University of Calcutta for the promotion of scientific and technical education in Bengal. University chairs of chemistry and physics which can be filled only by persons of Indian birth were created from this fund. In 1913 Sir Rash Behary Ghose gave 10 lakhs of rupees (66,666*l*.) to the University for the establishment of chairs of applied mathematics, physics, chemistry, and botany, all in relation to agriculture; these again can be held only by Indians. A year or so ago this gift was supplemented by a further sum of 11 lakhs of rupees (73,332*l*.), given by Sir Rash Ghose for the proposed technological branch of the College of Science. This gift enabled the University to send Sir Prafulla Chandra Rây, the dean of the faculty of science, on a three months' tour of the universities of Great Britain. Sir P. C. Rây is a distinguished chemist who has been closely associated with numerous industrial concerns in Bengal, and he has been appointed to supervise the equipment of the technological department, while four young research workers are being trained in London under the terms of Sir Rash Ghose's gift.

Calendar of Scientific Pioneers.

February 10, 1868. Sir David Brewster died.—A founder of the British Association and the biographer of Newton, Brewster made important discoveries in optics, for which he was awarded the Rumford, Royal, and Copley medals of the Royal Society.

February 10, 1878. Claude Bernard died.—A great physiologist, Bernard for many years held the chair of experimental physiology at the Collège de France.

February 10, 1891. Sonia Kovalevsky died.—One of the best known of women mathematicians, Sonia or Sophie Kovalevsky studied under Weierstrass, and after her husband's death in 1883 became professor of higher mathematics at Stockholm.

February 11, 1650. René Descartes died.—Born in 1596, and educated by the Jesuits, Descartes served for a while in the Army, and in 1629 settled in Holland, where his principal works were written. He has been called "the father of modern philosophy." He made many improvements in mathematics, and is regarded as the founder of analytical geometry. His theory of vortices, devised to explain the motion of the heavenly bodies, held the field until it was superseded by the Newtonian philosophy. He died at Stockholm, but his remains now rest in Paris. On the pedestal of his statue at Tours is inscribed, "Je pens, donc je suis."

February 11, 1868. Jean Bernard Léon Foucault died.—To Foucault we owe the demonstration, by means of the pendulum and the gyroscope, of the rotation of the earth. In 1850 he showed that light travelled more slowly through water than through air. He was physicist to the Paris Observatory.

February 12, 1787. Ruggiero Giuseppe Boscovich died.—The Society of Jesus has produced many notable workers in science, but none with a wider reputation than Boscovich. He was a mathematician, physicist, and astronomer, and is remembered for the famous theory of matter which he propounded. For some years he resided in Paris. His last days were passed in neglect and misery, and he died insane at Milan.

February 12, 1799. Lazaro Spallanzani died.—Holding various chairs at Modena and Padua, Spallanzani was interested in all branches of science, but his main discoveries related to physiology. He especially studied digestion and fertilisation.

February 13, 1839. Edward Turner died.—The first professor of chemistry in the University of London, Turner made many accurate determinations of atomic weights.

February 13, 1909. Hans Peter Jürgen Julius Thomsen died.—An educationist, administrator, and technologist, Thomsen held the chair of chemistry at Copenhagen. He made long and important investigations in thermo-chemistry, comparable with those of Berthelot.

February 14, 1744. John Hadley died.—A mathematician and scientific mechanist, Hadley produced the first serviceable reflecting telescope and invented the reflecting quadrant.

February 15, 1680. Jan Swammerdam died.—While practising as a doctor at Amsterdam and Leyden, Swammerdam became one of the earliest and most successful entomologists. He especially studied the anatomy of the bee.

February 15, 1736. Stephen Gray died.—The first recipient of the Copley prize of the Royal Society, Gray was a pensioner in the Charterhouse, London, where he made many successful electrical experiments.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, January 27.—Prof. C. S. Sherrington, president, in the chair.—K. **Sassa** and Prof. C. S. **Sherrington**: The myogram of the flexor-reflex evoked by a single break-shock. In the spinal preparation excess of the reflex contraction over maximal twitch indicates that summation of successive contraction-waves is present in the former. Repetitive discharge from the reflex centre occurs, therefore, in response to a stimulus consisting of a single induction shock.—Sir Almroth **Wright**: "Intertraction" between albuminous substances and saline solutions. It is demonstrated by means of experiments in which serum is directly superimposed upon heavier salt solutions, and of corresponding experiments in which lighter salt solutions are superimposed upon heavier serum, that the fluids thus brought into conjunction interpenetrate with extreme rapidity. The phenomena are due to an interaction between the salts and the albuminous substances. The designation "intertraction" is applied to this form of interaction; and it is suggested that these forces supplement diffusion. In supplementary experiments it is shown that by intertraction microbes lodged in serum are rapidly carried down into heavier, or caught up into lighter, salt solutions.—Dr. S. **Russ**, Dr. Helen **Chambers**, and Gladwys M. **Scott**: The local and generalised action of radium and X-rays upon tumour growth. The local effects of the β- and γ-rays from radium and X-rays upon rat tumours, under varying conditions, were obtained by exposing the tumour only to measured quantities of radiation. When large doses are employed destructive action upon the tumour-cells is observed; as the dose is reduced the action tends to become stimulative in character, so that the tumour-cells grow more rapidly. The generalised effects of the rays used were obtained by submitting the whole animal to the radiation, the tumour being screened. Large generalised doses could not be borne by the animals; with repeated small doses an increase in body-weight and in resistance towards tumour growth was observed. The bearing of the observations on radiation treatment in man is discussed.

PARIS.

Academy of Sciences, January 10.—M. Georges Lemoine in the chair.—P. **Marchal**: The utilisation of ladybirds against insects harmful to cultivation in the South of France. Specimens of *Cryptoloemus Montrouzieri* obtained from America have been cultivated at Mentone, and colonies were liberated in that town and the neighbourhood. It was proved that the insects could pass the winter in the open air in spite of an unusually low temperature.—M. **Lugeon** and J. **Villemagne**: An old glacial bed of the Rhone between Léaz and Pont-Rouge des Usses (Haute-Savoie).—A. **Schaumasse**: Observations of the Skjellerup comet (1920*b*) made with the bent equatorial at Nice Observatory. Positions are given for December 16, 20, and 23. The comet was of 10·5 magnitude, about 1·5′ diameter, with an ill-defined nucleus.—G. **Fayet** and A. **Schaumasse**: Provisional elements of the new comet 1920*b* (Skjellerup).—H. **Godard**: Observations of the Skjellerup comet made at the Bordeaux Observatory with the 38-cm. equatorial.—S. **Posternak**: The tetrabasic polymolybdates.—E. **Chaput**: Observations on the old alluvia of the Seine.—L. **Cayeux**: The mineralogical evolution of the oolitic iron minerals of France, independent of the time factor.—A. **Guilliermond**: The morphological constitution of the cytoplasm.—E. **De Wildeman**: The theories of myrmecophily.—G. **Mangenot**: The "fucosane grains" of the Pheophyceæ.—H. **Lagatu**: The respective *rôles* of the three bases, potash, lime, and magnesia, in cultivated plants. The K : Ca : Mg ratios for a large number of plants are plotted on a rectangular isosceles triangle. The results explain experimental figures recently obtained by the use of calcined dolomite as a manure.—E. **Lombard**: A collection of phenomena, clinical and experimental, permitting the study of the functional state of the vestibular apparatus in its relations with organic equilibrium.—M. **Doyon**: The anti-coagulating action of the nucleic acid of the pancreas. The stability and characters of the nucleated plasma.—A. **Mayer**, H. **Magne**, and L. **Plantefol**: The toxicity of the chlorinated methyl carbonates and chlorocarbonates. Thirteen chlorine derivatives of methyl carbonate were studied; the results are expressed graphically with substituted chlorine atoms as abscissæ and minimum focal concentrations as ordinates.—P. **Chabanaud**: A new Batrachian in intertropical Africa. The larva found appears to be that of *Triton Poireti*, although there are some differences.

January 17.—M. Georges Lemoine in the chair.—C. **Guichard**: Couples of two O_1 congruences, reciprocal polars, with respect to a linear complex.—T. **Varopoulos**: Functions having a finite or infinite number of branches.—C. **Trémont**: The testing of thin metal sheets by stamping. Two methods are described, one for metal sheets utilised for their rigidity, the other for resistance to shock. Some data obtained with sheets of steel, copper, brass, and aluminium are given.—H. **Villat**: The initial flow of a liquid through an orifice opened suddenly.—R. **de Mallemann**: The variation of the rotatory power of tartaric acid. The marked increase in the rotatory power of solutions of tartaric acid caused by the addition of certain weak acids (boric, molybdic, tungstic, etc.) has been attributed to the formation of new chemical compounds of high rotatory power. The author describes modifications of rotatory power produced by the chlorides and nitrates of the alkalis and alkaline earths which appear to be due to another cause. The rotatory power diminishes and then changes its sign; the dispersion changes follow a definite law.—G. **Chaudron**: Reversible reactions of carbon monoxide with the oxides of iron. The composition of the gaseous phase in this equilibrium has been determined by an interference method. Below 580° C. there is a single system corresponding to the equation

$$Fe_3O_4+4CO \rightleftharpoons 4CO_2+3Fe.$$

Below 580° C. there are two equilibria corresponding to

$$Fe_3O_4+CO \rightleftharpoons 3FeO+CO_2.$$
$$FeO+CO \rightleftharpoons Fe+CO_2.$$

A diagram is given, plotted from the experimental figures showing the three branches of curves corresponding to these systems.—J. B. **Senderens**: The catalytic decomposition of the chloroacetic acids. Whilst acetone is readily formed by the catalytic decomposition of acetic acid, the chloroacetic acids are split up in quite a different manner. Monochloroacetic acid gives carbon monoxide and dioxide, aqueous hydrochloric acid, and a little ethylene chloride; trichloroacetic acid gives the same gases with a little phosgene, with a condensed liquid containing chloroform, tetrachloroethylene, and a little hexachloroethane. Thoria and kaolin have practically identical catalytic actions in these decompositions; but animal charcoal gives different products with trichloroacetic acid, 85 per cent. of the distillate consisting of chloroform.—M. **Delépine** and P. **Jaffeux**: The two homologues of ethylene sulphide, 1 : 2-thiopropane and 1 : 2-thiobutane. These two sulphides have been prepared in a pure state, and their principal physical constants are given and compared with the isomers described by Grichkévitch-Trokhimovsky.—R. **Fosse**: The synthesis of cyanic acid by the oxidation of formamide and of oxamic acid. Formamide was oxidised by potassium permanganate in strongly ammoniacal solution and the resulting solution heated with ammonium chloride; urea was proved to be present by the xanthydrol reaction.—C. **Dufraisse**: The auto-oxidation of α-bromostyrolene.—O. **Mengel**: The inter-Glacial and post-Glacial tectonic movements of the eastern end of the Pyrenees.—C. **Dufour**: The values of the magnetic elements at the Val-Joyeux Observatory on January 1, 1921.—Ad. Dawy **de Virville**: Modification of the form and structure of a moss (*Hypnum commutatum*) kept under water. After six months marked changes in the mode of growth were observed.—E. **Miège**: The action of chloropicrin on the germinative faculty of seeds. The destruction of parasitic insects on seeds with chloropicrin vapour is readily carried out, but in some cases the seeds are injuriously affected. Leguminous seeds are not injured by this treatment.—P. **Mazé**: The chemical mechanism of the assimilation of carbon dioxide by green plants.—A. **Pézard**: The latent period in experiments of testicular transplantation and the law of "all or nothing."—M. **Marage**: The limits of audition.—C. **Porcher** and L. **Panisset**: Experimental researches on colostrum. Colostrum is not a special fluid secreted by the mammary gland, but the product of phagocytosis of ordinary milk; it is a product of retention. The lactose is absorbed, and the phagocytes attack the colloids and fat globules.—E. **Kayser**: The influence of light radiations on the azotobacter.—H. **Vallée** and H. **Carré**: The adsorption of the aphthous virus.

Books Received.

The Development of Institutions under Irrigation. By Prof. G. Thomas. Pp. xi+293. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 16s. net.

Laboratory Projects in Physics: A Manual of Practical Experiments for Beginners. By F. F. Good. Pp. xiii+267. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 9s. net.

The Origin and Development of the Nervous System from a Physiological Viewpoint. By Prof. C. M. Child. Pp. xvii+296. (Chicago: University of Chicago Press; London: Cambridge University Press.) 1.75 dollars net.

An Introduction to Zoology for Medical Students: By Prof. C. H. O'Donoghue. Pp. x+501. (London: G. Bell and Sons, Ltd.) 16s. net.

Mechanism, Life, and Personality: An Examination of the Mechanistic Theory of Life and Mind. By Dr. J. S. Haldane. Second edition. Pp. vii+152. (London: J. Murray.) 6s. net.

New Studies of a Great Inheritance: Being Lectures on the Modern Worth of some Ancient Writers. By Prof. R. S. Conway. Pp. viii+241. (London: J. Murray.) 7s. 6d. net.

First Course in General Science. By Prof. F. D. Barber and others. Pp. vii+607. (New York: H. Holt and Co.; London: G. Bell and Sons, Ltd.) 9s. net.

Elementary Vector Analysis: With Application to Geometry and Physics. By Dr. C. E. Weatherburn. Pp. xxvii+184. (London: G. Bell and Sons, Ltd.) 12s. net.

Anuario del Observatorio de Madrid para 1921. Pp. 591. (Madrid.)

Botany with Agricultural Applications. By Prof. J. N. Martin. Second edition, revised. Pp. xii+604. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 21s. net.

A Laboratory Manual of Organic Chemistry for Medical Students. By Prof. M. Steel. Second edition, revised. Pp. xi+284. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 9s. 6d. net.

Geography for Junior Classes. By E. Marsden and T. Alford Smith. Pp. viii+278. (London: Macmillan and Co., Ltd.) 5s.

Purpose and Transcendentalism. An Exposition of Swedenborg's Philosophical Doctrines in Relation to Modern Thought. By H. S. Redgrove. Pp. xvi+170. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co.) 5s. net.

The Carnegie Trust for the Universities of Scotland. Nineteenth Annual Report (for the Year 1919–20) Submitted by the Executive Committee to the Trustees on February 9, 1921. Pp. iv+102. (Edinburgh: T. and A. Constable and Co., Ltd.)

Orographical, Regional, and Economic Atlas. Edited by T. Franklin. Part 3: Asia. Pp. 32. (Edinburgh: W. and A. K. Johnston, Ltd.; London: Macmillan and Co., Ltd.) 1s. 6d. net.

Memoirs of the Geological Survey. Special Reports on the Mineral Resources of Great Britain. Vol. xii.: Iron Ores (continued). Bedded Ores of the Lias, Oolites, and Later Formations in England. By G. W. Lamplugh and others. Pp. iv+240+viii plates. 12s. 6d. net. Vol. xiv.: Refractory Materials: Fireclays. Resources and Geology. Pp. iv+243+iv plates. 8s. net. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd.)

Diary of Societies.

THURSDAY, FEBRUARY 10.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. A. Herdman: Oceanography (Problems of the Plankton).

ROYAL SOCIETY, at 4.30.—Rev. John Roscoe: Certain Ethnological Features of Uganda.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Prof. A. S. Eddington: World Geometry (with particular reference to Weyl's Electromagnetic Theory).—J. Brill: Note on the Electromagnetic Equations.—J. E. Littlewood: Researches in the Theory of the Riemann Zeta-function.—S. Pollard: A New Condition for Cauchy's Theorem.—I. J. Schwatt: (1) An Independent Form of the Numbers of Bernoulli; (2) Euler's Numbers of Higher Order; (3) Certain Numbers which are related to Euler's Numbers of Higher Order.—S. Timoshenko: (1) The Tension of a Prism one of the Cross-sections of which remains Plane; (2) The Analogy with Membranes in the Case of the Bending of a Prism.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. G. H. Miles: Vocational Tests.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Discussion on Electric Appliances for Domestic Purposes, to be introduced by Dr. E. Griffiths and F. H. Schofield in a Paper on Some Thermal Characteristics of Electric Ovens and Hot Plates.

LONDON DERMATOLOGICAL SOCIETY, at 6.—Dr. Sibley: Alopecia (Chesterfield Lecture).

OPTICAL SOCIETY, at 7.30.

ROYAL SOCIETY OF MEDICINE (Neurology Section) (at National Hospital for Paralysis and Epilepsy), at 8.

FRIDAY, FEBRUARY 11.

ROYAL ASTRONOMICAL SOCIETY (Anniversary Meeting), at 5.

ROYAL SOCIETY OF MEDICINE (Clinical Medicine, Surgery), Joint Meeting, at 5.—Dr. H. Mackenzie, J. Berry, and Others: Discussion: The Medical and Surgical Treatment of Graves' Disease.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. G. T. Fisher: Loose Bodies in Joints.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—Discussion on Absolute Measurements of Electrical Resistance, and Instruments Based on the Temperature-variation of Resistance.—Sir Richard Glazebrook and F. E. Smith: Absolute Measurements of Electrical Resistance.—Resistance Thermometry: Prof. H. L. Callendar: The Compensated Resistance Bridge, and Instrument for the Measurement of Radiation.—C. R. Darling: The Early Work of Siemens on the Resistance-Pyrometer.—

C. Jakeman: The Measurement of Steam Temperatures.—The Hot-Wire Microphone: Major W. S. Tucker: The Function of the Convection Current in the Hot-Wire Microphone.—Capt. E. J. Paris: Theory of the Tucker Microphone.—Anemometry and Heat Convection: Prof. J. T. McGregor Morris: A Hot-Wire Anemometer.—Dr. J. S. G. Thomas. A Directional Hot-Wire Anemometer.—A. H. Davis: An Instrument for Measuring Convected Heat.—Miscellaneous Applications: Dr. G. A. Shakspear: A Gas Permeameter.—Prof. Leonard Hill: The Caleometer.—E. A. Griffiths: Liquid Depth Gauge (Distant Reading Type).—Dr. Daynes: A CO_2 Recorder.—Dr. E. Griffiths: Electrical Hygrometers.

MONTESSORI SOCIETY (at University College), at 5.45.—Miss M. Drummond: The Psychological Basis of the Montessori Method.

JUNIOR INSTITUTION OF ENGINEERS (at Caxton Hall), at 8.—F. A. Simpson: Some Limit Gauges.

INSTITUTE OF INDUSTRIAL ADMINISTRATION (at Central Hall, Westminster), at 8.—Sir Lynden Macassey: Present-Day Industrial Psychology.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—B. T. Lang: Scotometry.—Dr. T. H. Butler: Late Infections after Sclerectomy.—M. L. Hepburn: Some Notes on Trephining.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. F. W. Aston: Isotopes and Atomic Weights.

SATURDAY, FEBRUARY 12.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. Fowler: Spectroscopy (Experimental Spectroscopy).

PHYSIOLOGICAL SOCIETY (at National Institute for Medical Research, Mount Vernon, Hampstead), at 4.

MONDAY, FEBRUARY 14.

BIOCHEMICAL SOCIETY (at University College).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 4.—Sir Charters J. Symonds: Hunterian Oration.

INSTITUTE OF ACTUARIES, at 5.—F. A. A. Menzler: The Census of 1921: Some Remarks on Tabulation.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Lt.-Col. E. A. Tandy: The Circulation in the Earth's Crust.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting) (at Chartered Institute of Patent Agents), at 7.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Special Lecture), at 7.—Sir John Dewrance: Generation of Steam.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—W. E. Willink: The Cunard Building.

ROYAL SOCIETY OF ARTS, at 8.—Dr. E. K. Rideal: Applications of Catalysis to Industrial Chemistry (Cantor Lecture).

MEDICAL SOCIETY OF LONDON (at 11 Chandos Street, W.1), at 8.30.—Sir James Galloway and Others: Discussion on Skin Disease: Its Relation to Internal Disorder.

ROYAL SOCIETY OF MEDICINE (War Section), at 9.

TUESDAY, FEBRUARY 15.

ROYAL SOCIETY OF MEDICINE (Therapeutics and Pharmacology Section), at 4.30.—Dr. J. H. Burn: A Comparison of Digitalis Tinctures by Different Physiological Methods.—Dr. P. Hamill: Pituitary Extracts given by the Mouth (Experimental).—Dr. Donaldson: Pituitary Extracts given by the Mouth (Clinical).

ROYAL SOCIETY OF MEDICINE, at 5.—General Meeting.

ROYAL STATISTICAL SOCIETY, at 5.15.—Dr. J. Bonar: The Mint and the Precious Metals in Canada.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—P. de Chambrier: Working Petroleum by means of "Pits" and "Galleries."

WEDNESDAY, FEBRUARY 16.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Dr. F. W. Edridge-Green: The Cause and Prevention of Myopia (Arris and Gale Lecture).

ROYAL SOCIETY OF ARTS, at 8.—Dr. W. Cramp: Pneumatic Elevators in Theory and Practice.

ROYAL METEOROLOGICAL SOCIETY, at 8.—M. de Carle S. Salter: A New Method of Constructing Average Monthly Rainfall Maps.—G. A. Clarke: An Unusual Pilot-balloon Trajectory.

ROYAL MICROSCOPICAL SOCIETY, at 8.

HUNTERIAN SOCIETY (at Sion College), at 9.—Dr. H. H. Bashford: The Ideal Element in Medicine.

THURSDAY, FEBRUARY 17.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. A. Herdman: Oceanography (The Sea-Fisheries).

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Dr. C. Chree: A Comparison of Magnetic Declination Changes at British Observatories.—Prof. H. M. Macdonald: The Transmission of Electric Waves Around the Earth's Surface.—Prof. T. H. Havelock: The Stability of Fluid Motion.—Prof. W. H. Young: The Transformation of Integrals.—J. L. Haughton and Kathleen E. Bingham: The Constitution of the Alloys of Aluminium, Copper, and Zinc containing High Percentages of Zinc.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. Martin Flack: Respiratory Efficiency in Relation to Health and Disease (Milroy Lecture).

LINNEAN SOCIETY, at 5.—Prof. G. B. De Toni: A Contribution to the Teratology of the Genus Datura.—Capt. J. Ramsbottom and A. J. Wilmott: A Plant Collection from Macedonia.—Dr. G. C. Druce: Shetland *Plantago* and Other Plants from the Northern Isles.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—F. Handley Page: The Handley Page Wing.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—E. H. Clifford: A Scheme for Working the City Deep Mine at a Depth of 7000 ft.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Prof. E. Wilson: Magnetic Susceptibility of Low Order: I. Instrumentation.

INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates' Meeting) (at 28 Victoria Street), at 7.30.—E. L. Bass: Engine Lubrication.

CHEMICAL SOCIETY, at 8.—L. J. Hudleston and H. Bassett: Equilibria of Hydrofluosilicic Acid. Part I. Mixtures of Hydrofluosilicic and Hydrofluoric Acids.—R. G. Fargher and H. King: Additive Compounds of Antipyrylaminodiacetic Acid and its Salts with Neutral Salts.—H. Bassett and T. A. Simmons: The System, Picric Acid—Phenyl Acridine.—F. S. Kipping: Organic Derivatives of Silicon. Part XXIV. *dl*-Derivatives of Silicoethane.—F. W. Atack: The Structural Isomerism of Oximes. Part I. Criticism of the Hantzsch-Werner Hypothesis of the Geometrical Isomerism of Carbon-Nitrogen Compounds.—F. W. Atack: The Structural Isomerism of Oximes. Part II. Constitution of Oximes.—F. S. Kipping: Organic Derivatives of Silicon. Part XXV. Saturated and Unsaturated Silicohydrocarbons Si_4Ph_8.

RÖNTGEN SOCIETY (at University College), at 8.15.—N. E. Luboshez: Intensifying Screens and Secondary Radiation.

FRIDAY, FEBRUARY 18.

ASSOCIATION OF ECONOMIC BIOLOGISTS, Annual General Meeting (in Botanical Lecture Theatre, Imperial College of Science), at 2.30.—Sir David Prain: Some Relationships of Economic Biology.

GEOLOGICAL SOCIETY OF LONDON, at 3.—Anniversary Meeting.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—J. F. Dobson: The Function of the Kidneys in Enlargement of the Prostate Gland (Arris and Gale Lecture).

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Annual General Meeting.—F. M. Farmer: The Desirability of Standardisation in the Testing of Welds.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Section) (at King's College, Strand), at 6.30.—L. B. Atkinson: Presidential Address.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—S. J. Solomon: Strategic Camouflage.

SATURDAY, FEBRUARY 19.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. Fowler: Spectroscopy (Regularity in Spectra).

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Introduction.

SINCE 1905, when Prof. A. Einstein published his Principle of Relativity in its special form, much attention has been devoted to the subject in scientific circles, and during the last two or three years keen interest has been shown in it by many general readers of intellectual type. Nearly a thousand books, pamphlets, and papers have appeared in which the principle as a whole is described, or some of its aspects are discussed, and among these are a few which aim at making its character and consequences clear without the mathematical expressions which give it precise significance. A praiseworthy essay of this kind is that by Mr. L. Bolton, a senior examiner in the Patent Office, published in the *Westminster Gazette* on Monday by arrangement with the *Scientific American*, which awarded it a prize of five thousand dollars as the clearest explanation of Einstein's principle for general readers.

It is not difficult to understand why such wide interest is taken in this principle. No special knowledge is required to realise that measurements of space and time are essentially relative, and as all thinking people have pondered over the metaphysics of infinity and eternity, they are attracted by a conception in which these ideas are involved. The physicist is concerned with the principle because it developed out of experimental results of a negative kind, and is intimately associated with electromagnetic theory; the astronomer because it gives a new interpretation of effects not explained by the Newtonian law; and the mathematician because it provides him with a new space-time geometry. The principle has thus points of contact with many fields of scientific activity, and it is on this account that the present issue of NATURE is devoted to it.

We are gratified that so many leading authorities have been able to favour readers of this journal with surveys of the foundations of the principle or with their views as to the stability of the framework based upon them. Our own function has been limited to suggesting the scope of each article in the series, and, so far as possible, securing that the range of the whole covers the chief points around which discussion has centred. The writers have not seen one another's contributions, so that each article is an independent statement complete in itself so far as it goes. The order of the articles in the series is, therefore, important, and we believe that adopted will be considered appropriate to these columns.

Prof. Einstein describes the natural sequence of ideas which led to the conception of his principle, and Mr. Cunningham follows with a historical sketch of the conditions which demanded a revision of æther theories in relation to problems of absolute motion. The astronomical consequences—the displacement of light by the gravitational field of the sun, the movement of the perihelion of Mercury's orbit, and the displacement of solar spectrum lines (not yet established)—are dealt with by Sir Frank Dyson, Dr. Crommelin, and Dr. St. John respectively. The relation of Riemann's geometry of n-dimensions to the principle is outlined by Prof. Mathews; and the four articles which follow, by Mr. Jeans, Prof. Lorentz, Sir Oliver Lodge, and Prof. Weyl, are concerned mainly with physical aspects. How differently philosophers and astronomers regard the meaning and measurement of time is described by Prof. Eddington, and this article, with those by Dr. Norman Campbell and by Miss Wrinch and Dr. Jeffreys, leads naturally to the metaphysical conceptions presented by Prof. Wildon Carr.

Whatever may be the ultimate place taken by the principle of relativity in the history of science, no idea has ever proceeded by more logical steps from the rank of hypothesis to theory. In two cases predicted phenomena for which no satisfactory alternative explanation is forthcoming have been confirmed by observation, and the third is still a subject of inquiry. In this journal we are concerned mainly with the bearing of the principle upon physical science, and only incidentally with its metaphysical aspects. We may remark, however, that the absolute in Nature is not abolished by the principle. Measurements of time and space cease to be absolute and depend upon the motion of the observer, but things like energy and the velocity of light are independent of such motion and remain as absolute as ever they were.

A Brief Outline of the Development of the Theory of Relativity.

By PROF. A. EINSTEIN.

[Translated by Dr. Robert W. Lawson.]

THERE is something attractive in presenting the evolution of a sequence of ideas in as brief a form as possible, and yet with a completeness sufficient to preserve throughout the continuity of development. We shall endeavour to do this for the Theory of Relativity, and to show that the whole ascent is composed of small, almost self-evident steps of thought.

The entire development starts off from, and is dominated by, the idea of Faraday and Maxwell, according to which all physical processes involve a continuity of action (as opposed to action at a distance), or, in the language of mathematics, they are expressed by partial differential equations. Maxwell succeeded in doing this for electro-magnetic processes in bodies at rest by means of the conception of the magnetic effect of the vacuum-displacement-current, together with the postulate of the identity of the nature of electro-dynamic fields produced by induction, and the electro-static field.

The extension of electro-dynamics to the case of moving bodies fell to the lot of Maxwell's successors. H. Hertz attempted to solve the problem by ascribing to empty space (the æther) quite similar physical properties to those possessed by ponderable matter; in particular, like ponderable matter, the æther ought to have at every point a definite velocity. As in bodies at rest, electromagnetic or magneto-electric induction ought to be determined by the rate of change of the electric or magnetic flow respectively, provided that these velocities of alteration are referred to surface elements moving with the body. But the theory of Hertz was opposed to the fundamental experiment of Fizeau on the propagation of light in flowing liquids. The most obvious extension of Maxwell's theory to the case of moving bodies was incompatible with the results of experiment.

At this point, H. A. Lorentz came to the rescue. In view of his unqualified adherence to the atomic theory of matter, Lorentz felt unable to regard the latter as the seat of continuous electromagnetic fields. He thus conceived of these fields as being conditions of the æther, which was regarded as continuous. Lorentz considered the æther to be intrinsically independent of matter, both from a mechanical and a physical point of view. The æther did not take part in the motions of matter, and a reciprocity between æther and matter could be assumed only in so far as the latter was considered to be the carrier of attached electrical charges. The great value of the theory of Lorentz lay in the fact that the entire electrodynamics of bodies at rest and of bodies in motion was led back to Maxwell's equations of empty space. Not only did this theory surpass that of Hertz from the point of view of method, but with its aid H. A. Lorentz was also pre-eminently successful in explaining the experimental facts.

The theory appeared to be unsatisfactory only in *one* point of fundamental importance. It appeared to give preference to one system of co-ordinates of a particular state of motion (at rest relative to the æther) as against all other systems of co-ordinates in motion with respect to this one. In this point the theory seemed to stand in direct opposition to classical mechanics, in which all inertial systems which are in uniform motion with respect to each other are equally justifiable as systems of co-ordinates (Special Principle of Relativity). In this connection, all experience also in the realm of electro-dynamics (in particular Michelson's experiment) supported the idea of the equivalence of all inertial systems, *i.e.* was in favour of the special principle of relativity.

The Special Theory of Relativity owes its origin to this difficulty, which, because of its fundamental nature, was felt to be intolerable. This theory originated as the answer to the question: Is the special principle of relativity really contradictory to the field equations of Maxwell for empty space? The answer to this question appeared to be in the affirmative. For if those equations are valid with reference to a system of co-ordinates K, and we introduce a new system of co-ordinates K′ in conformity with the—to all appearances readily establishable—equations of transformation

$$\left.\begin{aligned} x' &= x - vt \\ y' &= y \\ z' &= z \\ t' &= t \end{aligned}\right\} \text{(Galileo transformation),}$$

then Maxwell's field equations are no longer valid in the new co-ordinates (x', y', z', t'). But appearances are deceptive. A more searching analysis of the physical significance of space and time rendered it evident that the Galileo transformation is founded on arbitrary assumptions, and in particular on the assumption that the statement of simultaneity has a meaning which is independent of the state of motion of the system of co-ordinates used. It was shown that the field equations for *vacuo* satisfy the special principle of relativity, provided we make use of the equations of transformation stated below:

$$\left.\begin{aligned} x' &= \frac{x - vt}{\sqrt{1 - v^2/c^2}} \\ y' &= y \\ z' &= z \\ t' &= \frac{t - vx/c^2}{\sqrt{1 - v^2/c^2}} \end{aligned}\right\} \text{(Lorentz transformation).}$$

In these equations x, y, z represent the co-ordinates measured with measuring-rods which are at rest with reference to the system of co-ordinates, and t represents the time measured with suitably adjusted clocks of identical construction, which are in a state of rest.

Now in order that the special principle of relativity may hold, it is necessary that all the equations of physics do not alter their form in the transition from one inertial system to another, when we make use of the Lorentz transformation for the calculation of this change. In the language of mathematics, all systems of equations that express physical laws must be co-variant with respect to the Lorentz transformation. Thus, from the point of view of method, the special principle of relativity is comparable to Carnot's principle of the impossibility of perpetual motion of the second kind, for, like the latter, it supplies us with a general condition which all natural laws must satisfy.

Later, H. Minkowski found a particularly elegant and suggestive expression for this condition of co-variance, one which reveals a formal relationship between Euclidean geometry of three dimensions and the space-time continuum of physics.

Euclidean Geometry of Three Dimensions.	*Special Theory of Relativity.*
Corresponding to two neighbouring points in space, there exists a numerical measure (distance ds) which conforms to the equation $ds^2=dx_1^2+dx_2^2+dx_3^2$.	Corresponding to two neighbouring points in space-time (point events), there exists a numerical measure (distance ds) which conforms to the equation $ds^2=dx_1^2+dx_2^2+dx_3^2+dx_4^2$
It is independent of the system of co-ordinates chosen, and can be measured with the unit measuring-rod.	It is independent of the inertial system chosen, and can be measured with the unit measuring-rod and a standard clock. x_1, x_2, x_3 are here rectangular co-ordinates, whilst $x_4=\sqrt{-1}\,ct$ is the time multiplied by the imaginary unit and by he velocity of light.
The permissible transformations are of such a character that the expression for ds^2 is invariant, *i.e.* the linear orthogonal transformations are permissible.	The permissible transformations are of such a character that the expression for ds^2 is invariant, *i.e.* those linear orthogonal substitutions are permissible which maintain the semblance of reality of x_1, x_2, x_3, x_4. These substitutions are the Lorentz transformations.
With respect to these transformations, the laws of Euclidean geometry are invariant.	With respect to these transformations, the laws of physics are invariant.

From this it follows that, in respect of its *rôle* in the equations of physics, though not with regard to its physical significance, time is equivalent to the space co-ordinates (apart from the relations of reality). From this point of view, physics is, as it were, a Euclidean geometry of four dimensions, or, more correctly, a statics in a four-dimensional Euclidean continuum.

The development of the special theory of relativity consists of two main steps, namely, the adaptation of the space-time "metrics" to Maxwell's electro-dynamics, and an adaptation of the rest of physics to that altered space-time "metrics." The first of these processes yields the relativity of simultaneity, the influence of motion on measuring-rods and clocks, a modification of kinematics, and in particular a new theorem of addition of velocities. The second process supplies us with a modification of Newton's law of motion for large velocities, together with information of fundamental importance on the nature of inertial mass.

It was found that inertia is not a fundamental property of matter, nor, indeed, an irreducible magnitude, but a property of energy. If an amount of energy E be given to a body, the inertial mass of the body increases by an amount E/c^2, where c is the velocity of light *in vacuo*. On the other hand, a body of mass m is to be regarded as a store of energy of magnitude mc^2.

Furthermore, it was soon found impossible to link up the science of gravitation with the special theory of relativity in a natural manner. In this connection I was struck by the fact that the force of gravitation possesses a fundamental property, which distinguishes it from electro-magnetic forces. All bodies fall in a gravitational field with the same acceleration, or—what is only another formulation of the same fact—the gravitational and inertial masses of a body are numerically equal to each other. This numerical equality suggests identity in character. Can gravitation and inertia be identical? This question leads directly to the General Theory of Relativity. Is it not possible for me to regard the earth as free from rotation, if I conceive of the centrifugal force, which acts on all bodies at rest relatively to the earth, as being a "real" field of gravitation, or part of such a field? If this idea can be carried out, then we shall have proved in very truth the identity of gravitation and inertia. For the same property which is regarded as *inertia* from the point of view of a system not taking part in the rotation can be interpreted as *gravitation* when considered with respect to a system that shares the rotation. According to Newton, this interpretation is impossible, because by Newton's law the centrifugal field cannot be regarded as being produced by matter, and because in Newton's theory there is no place for a "real" field of the "Koriolis-field" type. But perhaps Newton's law of field could be replaced by another that fits in with the field which holds with respect to a "rotating" system of co-ordinates? My conviction of the identity of inertial and gravitational mass aroused within me the feeling of absolute confidence in the correctness of this interpretation. In this connection I gained encouragement from the following idea. We are familiar with the "apparent" fields which are valid relatively to systems of co-ordinates possessing arbitrary motion with respect to an inertial system. With the aid of these special fields we should be able to study the law which is satisfied in general by gravitational fields. In this connection we shall have to take account of the fact that the ponderable masses will be the determining factor in producing the field, or, according to the fundamental result of the special theory of relativity, the energy density—a magnitude having the transformational character of a tensor.

On the other hand, considerations based on the metrical results of the special theory of relativity led to the result that Euclidean metrics can no longer be valid with respect to accelerated systems of co-ordinates. Although it retarded the progress of the theory several years, this enormous difficulty was mitigated by our knowledge that Euclidean metrics holds for small domains. As a consequence, the magnitude *ds*, which was physically defined in the special theory of relativity hitherto, retained its significance also in the general theory of relativity. But the co-ordinates themselves lost their direct significance, and degenerated simply into numbers with no physical meaning, the sole purpose of which was the numbering of the space-time points. Thus in the general theory of relativity the co-ordinates perform the same function as the Gaussian co-ordinates in the theory of surfaces. A necessary consequence of the preceding is that in such general co-ordinates the measurable magnitude *ds* must be capable of representation in the form

$$ds^2 = \sum_{uv} g_{uv} dx_u dx_v$$

where the symbols g_{uv} are functions of the space-time co-ordinates. From the above it also follows that the nature of the space-time variation of the factors g_{uv} determines, on one hand the space-time metrics, and on the other the gravitational field which governs the mechanical behaviour of material points.

The law of the gravitational field is determined mainly by the following conditions: First, it shall be valid for an arbitrary choice of the system of co-ordinates; secondly, it shall be determined by the energy tensor of matter; and thirdly, it shall contain no higher differential coefficients of the factors g_{uv} than the second, and must be linear in these. In this way a law was obtained which, although fundamentally different from Newton's law, corresponded so exactly to the latter in the deductions derivable from it that only very few criteria were to be found on which the theory could be decisively tested by experiment.

The following are some of the important questions which are awaiting solution at the present time. Are electrical and gravitational fields really so different in character that there is no formal unit to which they can be reduced? Do gravitational fields play a part in the constitution of matter, and is the continuum within the atomic nucleus to be regarded as appreciably non-Euclidean? A final question has reference to the cosmological problem. Is inertia to be traced to mutual action with distant masses? And connected with the latter: Is the spatial extent of the universe finite? It is here that my opinion differs from that of Eddington. With Mach, I feel that an affirmative answer is imperative, but for the time being nothing can be proved. Not until a dynamical investigation of the large systems of fixed stars has been performed from the point of view of the limits of validity of the Newtonian law of gravitation for immense regions of space will it perhaps be possible to obtain eventually an exact basis for the solution of this fascinating question.

Relativity: The Growth of an Idea.

By E. Cunningham.

Saccheri, in his "Logica Demonstrativa," published in 1697, ten years after Newton's "Principia Mathematica," lays down a distinction between *real* and *nominal* definitions which should be kept in mind if we are to do justice to Newton. Euclid defines a square as a four-sided figure the sides of which are all equal, and the angles of which are all right-angles. That is what he means by the name "square." It is a *nominal* definition. It remains to be shown that such a figure exists. This is done in Book I., Prop. 46. The definition then becomes *real*. Euclid is not guilty of the error of presupposing the existence of the figure.

Newton prefixes to his principles of natural philosophy certain definitions of absolute, true, and mathematical space and time. The former remains fixed and immovable; the latter flows uniformly on, without regard to material bodies. He strives here against the imperfections of language to give words to the thought in the back of his mind. The philosopher attacks him on these definitions; he has no right to presuppose that these words correspond to any reality. What then? Suppose these offending definitions removed, or recognised as purely nominal. Then the definitions of velocity, acceleration, mass, and force are nominal, too, and the whole of Newton's structure of dynamics is a paper scheme of words and relations which may or may not correspond to the world of sense.

But that is exactly what it is. That is what all scientific theory is, until experiment demonstrates that the correspondence exists. The justification of Newton's theory comes, not in the discovery of a time that flows uniformly on, but in the fact that the observed phenomena of the tides, of planetary motion, and of mechanics in general do fit on to his scheme. But the fit does not consist in the agreement of clock-time or solar time with absolute time. It is in the mutual agreement of the motions of clocks, earth, planets, moon, tides, and the rest; so that it matters not a whit whether the time variable used in the calculations flows uniformly on, or whether it is the merest variable number devoid of any physical significance whatever.

Thus the great paradox, the stumbling-block of absolute rotation, is not one of logic. Nature thrusts it upon us. While we would all admit that *a priori* rotation relative to empty space is a meaningless term, yet there remain Newton's bucket and Foucault's pendulum; and, strive as we will, Newton's way of looking at them remains the simplest. We would all fain think that "acceleration relative to empty space" is an empty phrase, and yet Nature is such that Newton's system of dynamics made modern science possible. Whatever we may say of Newton's definitions, therefore, his space and time are natural products of Nature's laboratory, to be purified, perhaps, but not to be rejected as spurious.

The nineteenth century was the æther age. From Arago, in 1820, to Michelson and Morley (1881–1905), followed by Trouton, Noble, Rankine, and Brace, vain attempts were made to discover the earth's velocity through the æther. But what, after all, was this elusive medium? To Faraday doubtless it was as real as anything in the universe. His resolute insistence on the need for a medium of transmission of electrical action, his discovery of the induction of currents by changing magnetic fields, Maxwell's advocacy of his views, and the demonstration of the electromagnetic nature of light, led up directly to the electron theory of Lorentz and Larmor, in which the æther appears as the background of all material phenomena. Yet the æther, after all, was but a name, and the electron theory a formal scheme of relations; like Newton's scheme, it was to be verified by its correspondence with actual observation. When it comes to observation, the only possibility is to note the behaviour of material bodies. Thus the æther with the associated ideas of electric and magnetic intensity ranks *pari passu* with Newton's absolute time and space. It has no likeness with matter; it is even doubtful whether it is of such substantiality that any element of it has identity. It has been said of Larmor's account of it that it reduces the universe to a set of differential equations, which, of course, is to a great extent true of Newton's work also.

But the notable thing about this theory is that it leaves the problem of absolute motion and absolute rotation exactly at the point where Newton left it. It gives a reasonable account of the failure of Michelson and Morley and the rest to discover the earth's velocity relative to the æther, just as Newton's theory would show why its velocity in absolute space cannot be determined. The æther-builders succeeded too well, and constructed, not one, but an infinity of æthers, any one having a uniform translatory motion relative to any other. But in the new theory, as in the old, a body may be said in an absolute sense to be devoid of rotational motion.

With the lack of determinateness in the æther goes a similar ambiguity in the measures of time and space. Each of these æthers has its proper scale of time and space. Events which are simultaneous in one æther are not simultaneous in another, and, since none can tell which is the true æther, none can tell whether two events are simultaneous or not. This is where the theories of Lorentz and Larmor lead us; and yet they only suggest it without demonstrating it. For neither of them professed to give a complete account of the structure of matter. The relations they propose for the æthereal action need to be supplemented by hypotheses as to the nature of the electron before they make a complete scheme; and when it comes to this Lorentz suggests a hypothesis, that of the contracting electron, which is devised specially for the purpose of getting the æther to conceal itself.

This brings us to the point at which Einstein makes his very modest suggestion (1905) of testing the hypothesis that in the nature of things we must not expect ever to find evidence of an absolute velocity of the earth through space. The ground had been well prepared. The electron theory as generally accepted was taken as it stood. The only new idea was that whereas his predecessors clung to the thought that one æther with its associated system of space-time measurement was real and the rest fictitious, Einstein, in the absence of any distinguishing features, ranks them all alike. To which some replied, "Give us back our absolute time and our æther." Yet Einstein had logic on his side, for the definitions of æther and of time are definitions *quid nominis*, not *quid rei*.

Looking back, we realise two great gaps in the special principle of relativity as Einstein propounded it in 1905. The first is the same which revealed itself in Newton's theory. "Uniform motion in a straight line" is left as a phrase with meaning, a situation as intolerable to the philosopher as the recognition of "absolute rest." Further, while it accepted the electromagnetic theory intact as a common basis of the structure of matter, it took no account of the other common property of matter, gravitation, of which so far the electromagnetic theory offered no explanation. Einstein at once realised the gaps, however, and saw a relation between them. Gravitational problems are problems of acceleration. The magnitude of the velocity of an observer does not affect his sense of gravity, but the experience of the man in the lift is that his acceleration does so. Thus Einstein perceived that to settle his difference with the philosopher he must first reconcile gravitation. Whether he would ever have done it without the genius of Minkowski we cannot tell. But as a matter of history the pure mathematician, who surely had learned much from Riemann and Helmholtz, was the first to emphasise the profound unity between the categories of space and time that was suggested by Einstein's work. A universe of determinate relations, in which everything proceeds according to known laws, is one which may be surveyed as a great whole in which past, present, and future are one. It is a four-dimensional unity, and for Einstein any plane section through it could be the present. The history of a particle is a simple chain of points in that whole, a "world-line."

Now events moved fast. Minkowski gave the notion of a four-dimension universe. Riemann had initiated a method of geometry in any number of dimensions; Einstein had glimpsed the possibility that, taking gravitation into account, light might be subject to acceleration, which, being interpreted in Minkowski's fashion, meant that the ordinary Euclidean expression for the element of length in a four-dimension space must be generalised. This made the work of Riemann not only useful, but also prophetic. In 1853 he had written that "the ground of the measure relations existing in the universe, if continuous, must consist in the binding forces acting upon it." This really implies the whole relativity doctrine; it asserts that the measure relations of the phenomena perceived in the universe are incapable of determination on any absolute scale, independent of the phenomena themselves. Sixty years later Einstein perceives that the gravitational field must be included among those binding forces, and must affect profoundly the measure relations in every physical aspect. Having foreseen this, Riemann had proceeded to develop a non-Euclidean geometry in any number of dimensions, and thus the germ of the calculus that Einstein needed was created. With what success it was wielded is now well known.

Not so well known is the more recent work of Weyl. Einstein finds in universal gravitation the ground of the measure relations of the universe. But equally universal is the fact of electricity, and this universal "binding force" must equally take a part in those relations. The acuteness of Riemann's vision is doubly emphasised when we hear that Weyl discovers a further generalisation of his geometrical method which provides for electricity a place as natural and convincing as that taken by gravitation in Einstein's theory. But that is history yet in the making, and this article seeks only to traverse the course of history already complete.

Relativity and the Eclipse Observations of May, 1919.

By Sir Frank Dyson, F.R.S.

In 1915 Prof. Einstein predicted, as a consequence of the generalised theory of relativity, that a ray of light from a star would be bent in its passage through the sun's gravitational field. The amount of this deflection he gave as $1{\cdot}75''(a/r)$, where a is the sun's radius, and r the nearest distance of the ray to the sun's centre. As a ray of light reaches us in the direction of the tangent to its path, the apparent position of a star, photographed during an eclipse of the sun, should therefore be displaced by an angle $1{\cdot}75''(a/r)$ outwards from the sun's centre. The field of stars surrounding the sun should thus be distorted in a definite manner by an amount within the range of accurate astronomical observation. In Fig. 1, if a, b, c are the positions of the stars as seen at ordinary times, and if S is the centre of the sun during an eclipse, then the positions in which the stars are seen or photographed during an eclipse will be A, B, C. If a were at a distance 30′ from the sun's centre the displacement aA would be $0{\cdot}87''$, and if B were at a distance 90′ from the sun's centre its displacement would be $0{\cdot}27''$. These are, roughly speaking, the greatest and least displacements which can be obtained in practice. Nearer than 30′ from the sun's centre a star's image is liable to be drowned in the corona. At greater distances than 90′ good images can scarcely be obtained with a simple object glass, while a doublet or other combination introduces some difficulties.

These displacements, though small, are ten times as large as those met with in determinations of stellar parallax, and are determined in a precisely similar manner by comparison of photographs taken at different epochs. The field of stars photographed during the eclipse must be compared with the same field photographed when the sun is in another part of the sky. Experience shows that telescopes of as long focal length as practicable should be used, and that the eclipse field and comparison field should be photographed under as nearly as possible identical conditions as regards both the instruments themselves and the position of the field in the sky. With these precautions there was every reason to suppose that, given favourable weather, successful results would be obtained.

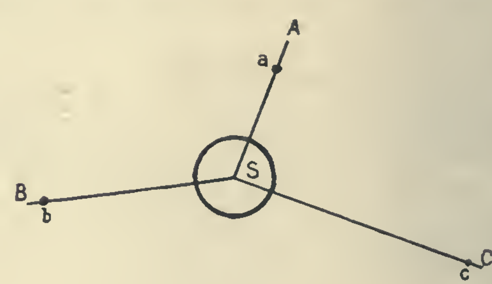

Fig. 1.

In the short time available for preparation it was not possible to arrange for the telescopes to be mounted equatorially, and the field of stars was reflected into fixed telescopes by cœlostat mirrors. The possibility had to be faced that the mirrors might suffer some distortion from the sun's heat. Apart from this, two of the mirrors did to some extent spoil the sharpness of the stellar images.

Three series of photographs were taken. Prof. Eddington and Mr. Cottingham at Principe had very cloudy weather, but obtained photographs showing a few stars. The check field obtained on two nights shortly after the eclipse gave images similar to those on the plates taken during the eclipse. The temperature during the eclipse was 77° F., and 76·5° F. when the check fields were taken. There was no reason to suppose any change of scale, and on this assumption the plates when measured gave for the deflection at the sun's limb $1{\cdot}61'' \pm 0{\cdot}30''$.

Dr. Crommelin and Mr. Davidson in Brazil were favoured with ideal weather conditions. They found, however, that the images on the eclipse plate differed from those taken the previous night, and from those taken on the same field of stars two months later. This is attributed to the effect of the sun's heat in distorting the cœlostat mirror. If it is assumed that the scale has changed, then the Einstein deflection from the series of plates is $0{\cdot}90''$; if it is assumed that no real change of focus occurred, but merely a blurring of the images, the result is $1{\cdot}56''$; little weight is, however, attached to this series of photographs.

With a smaller lens of 4-in. aperture and 19-ft. focus the same observers were extremely successful. The images taken during the eclipse are in sharp focus and exactly similar to those on the comparison field. The result of measurement gave $1{\cdot}98'' \pm 0{\cdot}12''$ for the deflection at the limb; seven stars were photographed, and the individual displacements, both in right ascension and in declination, were in good accordance with the law $1{\cdot}75''(a/r)$. It has been pointed out by Prof. H. N. Russell that the photographs show a difference of scale of one part in 12,000 in the horizontal and vertical directions of the cœlostat mirror, and that if allowance be made for this the results for individual stars will be in still closer accordance.

The result of the eclipse, particularly of the second series of photographs at Sobral, is a close verification of Einstein's predicted displacements $1{\cdot}75''(a/r)$ radial from the sun's centre.

We proceed to consider the objections raised against this result. It has been suggested that allowance was not made correctly for the ordinary terrestrial refraction. The method adopted was that usually employed in astronomical photography, the second order terms being omitted, as they in no case amount to more than $0{\cdot}02''$. The possibility of distortion of the film of the photographs, owing to the presence of the corona, has also been suggested. Examination of the plate in Phil. Trans., vol. ccxx., will show how different the conditions are from those cases in which distortion of the film has been observed. The possible displacements on the eclipse photographs could not amount to $0{\cdot}05''$ for any of the stars, and would be in the wrong direction.

Prof. Anderson made the interesting suggestion that a possible error might arise from the fall of temperature in the air as the moon's shadow moves over the place of observation, thus causing an exceptional refraction. It has been shown by Prof. Eddington and Sir Arthur Schuster (NATURE, vol. civ., pp. 372, 468) that this effect would in all cases be very much smaller than the quantities in question. Further, it happens that at Sobral, owing to cloud in the early morning, which checked the normal daily rise of temperature, the fall during the eclipse was not more than 2° or 3° F.

The possibility that the observed displacements may be due to refraction by gaseous matter surrounding the sun has received a good deal of consideration. If such an atmosphere is controlled entirely by the sun's gravitation, an impossibly high density is required. Prof. Newall has investigated the consequences of assuming that gravitation is partly balanced near the sun by electrical forces and radiation pressure assumed to vary as the inverse square of the distance from the sun's centre. To obtain agreement with the eclipse observations, he finds it necessary that 0·999 of the weight of the gas should be thus balanced. The difficulties of such a supposition have been pointed out by Prof. Lindemann (*Observatory*, April, 1920). Further, Dr. Crommelin has directed attention to the fact that several comets have approached nearer the sun than paths of the rays of some of the stars photographed at the eclipse, yet their motion has not been retarded, or their substance entirely vaporised, although they were for two hours at this small distance from the sun and moving with a velocity of 300 kilometres a second.

Relativity and the Motion of Mercury's Perihelion.

By DR. A. C. D. CROMMELIN.

THE effect of Einstein's law in changing the position of Mercury's perihelion is sometimes looked on as something mysterious and recondite; but in reality anything that disturbs the law of inverse squares in the smallest degree is bound to produce such a shift; and as in all the systems known to us such disturbing factors exist, the line of apses is invariably in motion.

It is easy to show that when the central force falls off more rapidly than the ratio of inverse squares, the apse-line *advances*; for we may consider the inverse square law as holding, with the addition of a small superposed force, outward in the outer half of the orbit, and inward in the inner half. These additional forces clearly cause the outward or inward motion to persist a little longer than it would otherwise do, thus delaying the attainment of the apses. It is proved in Tait and Steele's "Dynamics of a Particle," p. 127, that if the force vary as r^n, the apsidal angle in a nearly circular orbit is $\pi(3+n)^{-\frac{1}{2}}$. Put $n=-2(1+d)$, where d is very small, then the apsidal angle is $\pi(1-2d)^{-\frac{1}{2}}=\pi(1+d)$. Or, in a complete revolution, the apse advances $2\pi d$, which is a constant for all orbits.

This was the hypothesis advanced by Prof. Asaph Hall to explain the motion of Mercury's apses. The shift in the case of Mercury is $0{\cdot}1''$ per revolution. Applying this to the moon, it would give an apsidal advance of $135''$ per century above the amount indicated by Newtonian theory. At the time Prof. Newcomb adopted the Hall formula, there appeared to be such an excess of motion of the lunar perigee; but further research, both on the side of theory (Prof. Brown) and on that of observation (Dr. Cowell and others), has emphatically proved that the actual excess is far smaller, and quite consistent with the $2''$ per century resulting from Einstein's theory. Thus Brown found $14643527''$ and $14643511''$ for the theoretical centennial motion on two different assumptions of the earth's oblateness (Mon. Notices, vol. lxiv., p. 532). His discussion gave as the observed value $14643523''$, while Cowell found $14643538''$. In any case, the difference between theory and observation is very much smaller than that required by Hall's law. The latter is thus definitely put out of court, and it becomes a matter of regret that Newcomb adopted it in his tables of the four inner planets. It meant a more drastic alteration of the Newtonian law than that effected by Einstein; the former alters the law in all circumstances, while the latter leaves it unaltered for bodies at rest, but introduces a term that increases the force where there is relative motion.

The second suggestion in explanation of the motion of Mercury's apse is oblateness of the sun. It is easy to show that the attraction of an oblate body falls off more rapidly than the inverse square, thus producing advance of the apse of a satellite. Most of the satellites of the solar system afford examples; the most striking case is Jupiter V., the apse of which makes two entire revolutions in a terrestrial year. Where the satellite does not revolve in the equatorial plane of its primary, there is a second effect of oblateness; it causes the satellite's orbit-plane to shift, its pole describing a circle round the planet's pole. We may refer, for example, to the system of Mars. H. Struve determined the position of the pole of Mars and the amount of oblateness from observations of its satellites; similarly the position of Neptune's pole can be approximately inferred from the change in the orbit-plane of its satellite.

The amount of oblateness of the sun necessary to account for the motion of Mercury's perihelion is not great. Newcomb deduced that the necessary excess of the equatorial diameter over the polar would be slightly more than $\frac{1}{2}''$; the existence of even this small excess is rendered highly improbable by the very numerous measures of the solar disc, notably the heliometer measures in connection with the Venus-transits of 1874 and 1882; these were discussed by Dr. Auwers, and seemed, if anything, to indicate that the polar diameter is the greater. A further objection is that the solar equator is inclined 3° $21'$ to Mercury's orbit, and its oblateness would produce a diminution of $2{\cdot}6''$ per century in the inclination of Mercury's orbit. Observation, if anything, indicates a shift of the inclination in the opposite direction, and the amount $2{\cdot}6''$ is so far beyond the probable error as to render the theory of solar oblateness untenable. The above points were established by Newcomb, "Elements of the Four Inner Planets," in 1895, so that it is strange to find this untenable hypothesis still freely suggested in the United States.

It is fairly obvious that the portion of the zodiacal light that is inside Mercury's orbit would produce effects of the same general kind as those arising from solar oblateness. Now observations of the zodiacal light indicate a smaller inclination to the ecliptic than 7°, the inclination of Mercury's orbit. Thus J. F. J. Schmidt found values ranging from 4° to 0°, and Prof. Douglas's photograph, taken at Flagstaff, Arizona, on March 19, 1901, shows the light almost symmetrical on each side of the ecliptic. Now, unless the mean plane of the light agreed with that of Mercury's orbit, its gravitational effect on the apse of that planet would be accompanied by a shift of its orbital plane, not verified by observation. It has been found impossible to assign any position to hypothetical perturbing matter that would explain the apse motion of Mercury without causing other anomalies in the elements of that planet and of Venus, which are negatived by observation. Moreover, there is the difficulty that the zodiacal light, if of sufficient mass to produce such an effect, should give us more light than it does. Dr. H. Jeffreys examines the question in Mon. Not., vol. lxxx., p. 138. He shows that if the light arises from reflection by the molecules of a gas, the effect on Mercury would be only 1/3000 of that observed. If the light arises from reflection by solid particles, he takes 10 km. as their maximum admissible diameter (probably far in excess of what is really tenable); he still finds that their gravitational effect would be only 1/20 of that required. He makes similar calculations for the corona, reaching like conclusions.

Hence we seem to be driven by exhaustion to the Einstein law as the only satisfactory explanation. It clearly can have no effect on orbital planes, so it produces accordance in apsidal motion without introducing other anomalies. Further, it was not an *ad hoc* hypothesis; it was reached on independent grounds, and it was an undesigned coincidence that it fitted so well for

Mercury's apsidal motion. For the expression $3\left(\frac{\text{velocity of planet}}{\text{velocity of light}}\right)^2$, which is the angular motion of the apse (in fractions of a circumference) per revolution of the planet, involves no empirical or arbitrary constant. We can express the reason for the advance in simple terms thus: At infinity the relative velocity is zero, and the law is the Newtonian one, but the nearer we approach the central orb the higher becomes the velocity, and the greater the extra force. Hence we have another case of the force falling off more rapidly than the inverse square, which we have seen to lead to apsidal advance.

It is interesting to note that the advance per revolution varies as (velocity)^2 or as $1/a$. Hence the advance per century varies as $a^{-5/2}$, or it falls off much more rapidly with increase of a than the Hall law, which gives $a^{-3/2}$. In the course of centuries this would discriminate between them, independently of the lunar test; but the orbits of Venus and the earth are so nearly circular that the time for that test has not yet arrived.

In the case of Mars we may note that F. E. Ross's rediscussion of the observations of that planet and of the mass of Venus takes off some $2''$ from Newcomb's value of its excess of apsidal motion in a century. When we further remove the Einstein term $1{\cdot}3''$, we are left with some $2{\cdot}7''$; as the actually observed quantity is the product of $2{\cdot}7''$ by the eccentricity $(1/11)$, it falls well within the limits of observational error.

The Displacement of Solar Lines.

By Dr. Charles E. St. John, Mount Wilson Solar Observatory, Pasadena, California.

THE agreement of the observed advance of Mercury's perihelion and of the eclipse results of the British expeditions of 1919 with the deductions from the Einstein law of gravitation gives an increased importance to observations on the displacement of absorption lines in the solar spectrum relative to terrestrial sources, as the evidence on this deduction from the Einstein theory is at present contradictory. Particular interest, moreover, attaches to such observations, inasmuch as the mathematical physicists are not in agreement as to the validity of this deduction, and solar observations must eventually furnish the criterion.

Prof. Eddington's view, if I understand it, is that the theory cannot claim support from the present evidence, nor can observed displacements not agreeing with the theory be on that account regarded as in the slightest degree adverse to it, the only possible conclusion in his view being that there are certain causes of displacement of the lines acting in the solar atmosphere and not yet identified ("Space, Time, and Gravitation," p. 130).

The great majority of metallic lines observed for differences between their wave-lengths in the sun and terrestrial sources do show displacements. These differ in most cases from those deduced from the Einstein law of gravitation in ways as yet unexplained. If reasonable solar causes can be adduced to account for the wide discrepancies between theory and observation, the position of the generalised theory of relativity would be greatly strengthened.

According to the theory, the displacements are to the red, and are proportional to wave-length, being independent of the intensity of the lines and of the element to which they belong. Observational results differ from those deduced from the theory in at least four important ways. The observed displacements are not proportional to the wave-length; they differ from element to element in the same spectral region; for the same element and spectral region they vary with line-intensity; the displacements show both large positive and negative divergences from the calculated values. Interesting examples are found in Jewell's early work (*Astrophysical Journal*, vol. iii., p. 89, 1896). The relative values here are of high weight, and the data are important in that the range of elements is wider than occurs in more recent investigations. Divergences in the four directions from the calculated displacements are shown in the following extract from his observations on the differences in wave-length between 115 solar and arc lines:—

			Mean λ	Δ λ Obs.	Δ λ Cal.	Obs. – Cal.
Calcium	H,K,	4227	4042	+0·019	+0·009	+0·010Å
Calcium	Int.	1–6	5227	+0·004	+0·011	–0.007
Iron	,,	10–40	3950	+0·008	+0·008	±0·000
Iron	,,	2–8	3950	+0·003	+0·008	–0·005
Aluminium	,,	15–20	3950	+0·006	+0·008	–0·002
Nickel	,,	10–15	3530	+0·017	+0·008	+0·009
Nickel	,,	1–5	3625	+0·005	+0·008	–0·003
Copper	,,	6–9	3262	+0·006	+0·007	+0·009
Potassium	,,	00–0	4046	–0·008	+0·009	–0·017

For statistical discussion the quantity of data available is as yet quite inadequate even in the case of iron, the most widely studied element. Not only should the terrestrial and solar wave-lengths be known to high precision over the widest possible range of spectrum, but also the pressure shift per atmosphere. Unfortunately, there are no published data on the wave-lengths and pressure displacements of the iron lines, in which, over a long spectral range, the errors due to pole-effect in the arc are reduced to the magnitude of the calculated Einstein displacement. For other metallic elements the data are even more deficient. With a sufficiently large and varied accumulation of material there is hope that the complex solar conditions may be analysed, and the contributions to the observed effects arising from the various causes determined with some certainty. The pressing need is for data of the requisite accuracy and variety. This need adds interest to determinations of wave-lengths and of pressure displacements, and to investigations of the characteristic behaviour of spectrum lines, as all such data will have a part in solving one of the most absorbing questions in cosmic physics.

Evershed adduces his observations upon the spectrum of Venus as evidence of an "earth-effect" driving the gases from the earth-facing hemisphere of the sun, and he would by this hypothetical action explain the observed displacements of the solar lines, and thus negative the deduction from the Einstein theory. Two series of Venus observations have been made by Dr. S. B. Nicholson and myself. The details will appear in a forthcoming Contribution from the Mount Wilson Observatory. Our observations indicate that the displacements of the Venus lines to the violet relative to skylight are due to non-uniform illumination of the slit when the guiding is done upon the visual image, the effect increasing with the refraction and becoming more evident the smaller the image. The explanation is based upon the observation that spectrograms taken at low altitudes give larger displacements to the violet than those taken on the same night at higher altitudes, and that the displacements correlate with the cotangent of the altitude and the reciprocal of the diameter of the planet at the time of observation.

In respect to the observations at Mount Wilson on the lines of the cyanogen band at λ3883, I have as yet found no grounds for considering them seriously in error. The explanation of the results adverse to the theory based upon dissymmetry appears inadequate (*Observatory*, p. 260, July, 1920), and the assumption that the adverse results are due to superposed metallic lines seems to be negatived by the observations of Adams, Grebe, Bachem, and myself that for these lines there is no displacement between the centre and limb of the sun. Metallic lines as a class shift to the red in passing from the centre to the limb. If, then, metallic lines are superposed on these band lines in such a way as to mask the gravitational displacement to the red when observed at the centre of the sun, this should be revealed by a shift to the red at the limb.

The lines of the cyanogen bands are under investigation in the observatory laboratory both as reversed in the furnace and as produced in the arc under varying pressure. The measures show no evidence of a displacement to the red under decreased pressure as indicated by Perot's observations.

The present programme at Mount Wilson aims at an accumulation of varied and extensive data that will furnish a suitable basis from which to approach the general question of the behaviour of Fraunhofer lines relative to terrestrial sources.

Non-Euclidean Geometries.

By Prof. G. B. Mathews, F.R.S.

The ordinary theory of analytical geometry may be extended by analogy as follows: Let $x_1, x_2, \ldots x_n$ be independent variables, each ranging over the complete real (or ordinary complex) continuum. Any particular set $(x_1, x_2, \ldots x_n)$, in that order, is said to be a point, the co-ordinates of which are these x_i; and the aggregate of these points is said to form a point-space of n dimensions (P_n). Taking $r<n$, a set of r equations $\phi_1=0$, $\phi_2=0$, $\ldots$ $\phi_r=0$, connecting the co-ordinates, will in general define a space P_{n-r} contained in P_n. Theorems about loci, contact, envelopes, and the principle of duality all hold good for this enlarged domain, and we also have a system of projective geometry analogous to the ordinary one.

Physicists are predominantly interested in metrical geometry. The ordinary metrical formulæ for a P_3 may be extended by analogy to a P_n; there is no logical difficulty, but there is, of course, the psychological fact that our experience (so far) does not enable us to "visualise" a set of rectangular axes for a P_n if $n>3$; not, at least, in any way obviously analogous to the cases $n=2, 3$.

In ordinary geometry, for a P_3 we have the formula

$$ds^2=dx_1^2+dx_2^2+dx_3^2$$

for the linear element called the distance between two points (x), $(x+dx)$. Riemann asked himself the question whether, for every P_n, this was necessarily a typical formula for ds, on the assumption that solid bodies can be moved about in space without distortion of any kind. His result is that we may take as the typical form, referred to orthogonal axes,

$$ds^2=\Sigma dx^2/N^2,$$

where

$$N=1+\tfrac{1}{4}\alpha\Sigma x^2,$$

and α is an arbitrary constant, called the *curvature* of the P_n in question. This curvature is an intrinsic property of the P_n, and should not be considered as a warp or strain of any kind. When $\alpha=0$, we have the Euclidean case. As an illustration of the theory that can be actually realised, take the sphere $x^2+y^2+z^2=r^2$ in the ordinary Euclidean P_3. By putting

$$D=u^2+v^2+4r^2,$$
$$Dx,\ Dy,\ Dz=4r^2u,\ 4r^2v,\ (u^2+v^2-4r^2)r,$$

the equation $x^2+y^2+z^2=r^2$ becomes an identity, and we may regard the surface of the sphere as a P_2 with (u, v) as co-ordinates. The reader will easily verify that

$$ds^2=(du^2+dv^2)\div\{1+\frac{1}{4r^2}(u^2+v^2)\}^2;$$

so we have a case of Riemann's formula with $\alpha=r^{-2}$. We *cannot* find a similar formula for the surface of an ellipsoid, because a lamina that "fits" a certain part of the ellipsoid cannot be freely moved about so as to remain in contact with the surface.

To avoid misunderstanding, it should be said that Riemann's expression for ds^2 is not the only one that is taken to be the typical or standard formula. The important thing is that, given any formula for ds^2, in a P_n, we can, by direct calculation, find an expression for the curvature of P_n in the neighbourhood of any assigned point (x). It is only when this curvature is everywhere the same that we have a P_n for which the axiom of free mobility is valid. When the curvature varies from place to place we are not entitled, for instance, to assume that we can carry about an invariable foot-rule for purposes of physical measurement.

In the simpler theory of relativity we have a formula

$$ds^2 = dx^2 + dy^2 + dz^2 - c^2dt^2, \quad . \quad . \quad . \quad (1)$$

where c is a real constant. As it originally presents itself, x, y, z are ordinary rectangular coordinates, t is the time, and c the experimental velocity of light. By a suitable choice of units we can make the value of c any finite constant that we please. Following Minkowski, I shall call (x, y, z, t) a world-point; the aggregate of these points may be provisionally called a space-time world $P(x, y, z, t)$.

When $t = t_0$, a constant, $dt = 0$ and (1) reduces to the ordinary Euclidean formula. We may express this by saying that the sub-world $P(x, y, z, t_0)$ is Euclidean. Actual experiments take time; so we cannot verify this assertion by observation. If, however, two observers, at different places, make measurements which begin and end at the same instants, we may expect their results to be consistent. As Prof. Einstein has pointed out, the question of simultaneity (and, indeed, of time itself, as an *observed* quantity) is a more difficult one than appears at first sight.

The main difficulty about (1), as it seems to me, is that the expression on the right is not a definite form; hence in the neighbourhood of every "real" point (x, y, z, t) there is a real region for which ds^2 is negative. It is possible that the difficulty of interpretation is more apparent than real, as is the case in some well-known examples. For instance, a hyperbola may be analytically defined as an ellipse of semiaxes a, bi, where a, b are real; and, *moreover*, v. Staudt's theory of involution gives an actual geometrical meaning to the algebraic definition.

If, with $i^2 = -1$, we put $ct = i\tau$, the formula (1) becomes

$$ds^2 = dx^2 + dy^2 + dz^2 + d\tau^2, \quad . \quad . \quad . \quad (2)$$

the typical formula for a Euclidean P_4. This makes it very tempting to assume that the successions of phenomena in our world of experience are, so to speak, sections of a *space-world* $P(x, y, z, \tau)$, obtained by giving τ purely imaginary values. This point of view has been taken by Minkowski and others.

The mathematical theories of abstract geometry and kinematics are so complete that physicists have a definite set of hypotheses from which to choose the one most suited to their purpose; and besides this they have to frame axioms and definitions about time, energy, etc., with which the pure mathematician is not concerned.

Whatever may be the ultimate form given to the theory of relativity, the predictive quality of its formulæ gives it a high claim to attention, and it certainly seems probable that, for the sake of what Mach calls economy of thought, we may feel compelled to change our ideas of "actual" space and time.

In an article like this it is impossible to go into detail; the following references may be useful to readers who desire further information:—"The Elements of Non-Euclidean Geometry," by J. L. Coolidge, is rather condensed, but very conscientious and trustworthy; one of the best analytical discussions of the metrical theory is in Bianchi's "Lezioni di Geometria Differenziale," chap. xi.; and Lie's "Theorie der Transformationsgruppen," vol. iii., chaps. xx.–xxiv., contains a most valuable critique of Riemann and Helmholtz. The article "Geometry" in the "Encyclopædia Britannica" (last edition) gives an outline of the theory and numerous references. Finally, there is an elaborate "Bibliography of Non-Euclidean Geometry" by D. M. J. Somerville (see NATURE, May 16, 1912, vol. lxxxix., p. 266).

The General Physical Theory of Relativity.

By J. H. JEANS, Sec. R.S.

THE relativity theory of gravitation, which is at present the centre of so much interest, owes its existence to an earlier physical theory of relativity which had proved to be in accord with all the known phenomena of Nature except gravitation. The gravitational theory is only one branch, although a vigorous and striking branch, of a firmly established parent tree. The present article will deal solely with the main trunk and roots of this tree.

Newton's laws of motion referred explicitly to a state of rest, but also showed that the phenomena to be expected from bodies in a state of rest were precisely identical with those to be expected when the same bodies were moving with constant velocity. Indeed, Newton directed special attention to this implication of his laws of motion in the following words:—

COROLLARY V.: *The motions of bodies included in a given space are the same among themselves, whether that space is at rest, or moves uniformly forwards in a right line without any circular motion.*

"A clear proof of which we have," continues Newton, "from the experiment of a ship, where all motions happen after the same manner whether the ship is at rest, or is carried uniformly forward in a right line."

Thus no experiment on board ship can ever disclose the ship's velocity through the sea. The matter stands differently to one who is free to experiment with both the ship and the sea. Let a sailor walk to the end of the bowsprit and drop his lead into the sea. A circular ripple will spread out; but every sailor knows that the point at which his line enters the water will not remain at the centre of this circle. The velocity with which the point of entry advances from the centre of the circle will give the velocity of the ship through the sea.

If our earth is ploughing its way through a sea of æther, an experiment conceived on similar lines ought to reveal the velocity of the earth through the æther. The famous Michelson-Morley experiment was designed to this end. Our earth was the ship; the physical laboratory at Chicago was the bowsprit. The dropping of the lead into the sea was represented by the emission of a light-signal, and the wave-front emanating from this signal was the ripple on the sea of æther. In the original experiments of Michelson and Morley it was not possible to watch the progress of the ripple directly, but sufficient information was obtained by arranging mirrors to reflect the signal back to the starting-point. In the recent experiments of Majorana this difficulty is obviated, although at the cost of some loss of refinement.

From these and other experiments the result invariably emerges that the wave-front appears to be a sphere having the observer at its centre. Thus on the hypothesis that our earth is surrounded by a sea of æther, experiment shows that the velocity of the earth relative to this sea of æther is *nil*. We cannot suppose that the true velocity is always *nil*, for the earth is known to be describing circles around the sun at a speed of 30 km. a second, while the experiments were sensitive enough to detect a velocity of one-hundredth part of this.

In view of the complete success which has attended the hypothesis of relativity, it would scarcely seem to be necessary to do more than mention the various early hypotheses put forward to account for these and similar experimental results. Such were the hypotheses that the earth drags the æther along with it (Arago, 1818); that matter moving through the æther is contracted, as a result of its motion, in just such a way as eternally to conceal the earth's motion through the æther from our measurements (FitzGerald, 1893; Lorentz, 1895); and that light is a phenomenon of corpuscular emission (Ritz). Each of these hypotheses explained some only of the facts to be explained, and failed with others.

The theory of light has progressed largely through the construction of mechanical models. Every such model, if fruitful, suggests new laws to be tested. So long as the laws suggested in this way are confirmed by observation, the model stands; as soon as a predicted law is found to fail, the model must be amended or abandoned. Notable examples of such models have been the corpuscular model of Newton, the elastic-solid æther of Young and his followers, and the electromagnetic æther of Faraday and Maxwell. The first two of these have long ago served their purpose and passed away. The time has now clearly come when the last of these optical models, the electromagnetic æther, must be either amended or abandoned, and the indications are strong that the less drastic course will not suffice.

The construction of mechanical models is not, however, the only known means of guidance to the discovery of new laws of Nature. An even more fruitful means of progress has been provided by tentative generalisation of known laws. Proved laws *a, b, c, d* . . . are found to be special cases of a more general law A, and the truth of A is then seen to involve not only the detailed laws *a, b, c, d* . . . which have led to A, but also other detailed laws *p, q, r, s* . . . In this way we may be guided to test the suggested new laws *p, q, r, s* . . . , and the generalisation A is, of course, strengthened or discredited according as *p, q, r, s* . . . are confirmed by observation or not. Conspicuous instances of successful generalisations of this kind are provided by the conservation of energy and the second law of thermodynamics.

Early in the present century Einstein and Lorentz suggested a tentative generalisation of this type, which is now known as the hypothesis of relativity. Since all experiments so far performed had failed to disclose the velocity of the earth through the assumed æther, it was natural to generalise in the first place to the tentative principle that this velocity could not, from the nature of things, ever be revealed by any experiment whatever. Generalised somewhat further by the removal of the local reference to our earth, the hypothesis assumed the form that all phenomena of Nature are the same for an observer moving with any uniform velocity as they are for an observer at rest. This somewhat crude form of statement shows that the hypothesis merely generalises Newton's corollary V. quoted above, so as to make it apply to all the phenomena of Nature. Since, however, the acceptance of the hypothesis makes it impossible to define what is meant by a state of rest, it is better to express the hypothesis in the form that all the phenomena of Nature are the same for any two observers who move relative to one another with a constant velocity.

This hypothesis is known already to be true as regards the mechanical forces considered in Newton's laws. Naturally, also, it is true as regards the optical phenomena investigated in the Michelson-Morley and similar experiments, for it is out of these phenomena that the hypothesis arose. The crucial test occurs when laws in other fields of science are deduced from the hypothesis and compared with observation. The hypothesis has been very thoroughly tested in the field of electromagnetism, and in every single case has emerged triumphant. As conspicuous instances of its success may be mentioned: The explanation of Fizeau's water-tube experiment, the prediction of the law connecting electronic mass with velocity, and the prediction of ponderomotive electromagnetic forces in moving media.

One final, and therefore crucial, test remains: gravitation. It was soon noticed that the hypothesis was inconsistent with the exact truth of Newton's gravitational law of force mm'/r^2. Thus the hypothesis of relativity predicts that a freely moving planet cannot describe a perfect ellipse about the sun as focus. This prediction is made on quite general grounds, just as the conservation of energy predicts that a stream of water cannot flow uphill. But the conservation of energy by itself is powerless to predict what will be the actual course of a stream of water, and in precisely the same way the hypothesis of relativity alone is powerless to predict what will be the orbit of a planet. Before this or any other positive gravitational predictions can be made, additional hypotheses must be introduced. The main trunk of the tree is the relativity hypothesis already mentioned; these additional hypotheses form the branches. The trunk can exist without its branches, but not the branches without the trunk. Whether the branches have been placed on the trunk with complete accuracy is admittedly still an open question—it must of necessity remain so until the difficult questions associated with the gravitational shift of spectral lines have been finally settled—but the main trunk of the tree can be disturbed by nothing short of a direct experimental determination of the absolute velocity of the earth, and the only means which can possibly remain available for such a determination now are gravitational.

The Michelson-Morley Experiment and the Dimensions of Moving Bodies.

By Prof. H. A. Lorentz, For.Mem.R.S.

As doubts have sometimes been expressed concerning the interpretation of Prof. Michelson's celebrated experiment, some remarks on the subject will perhaps not be out of place here. I shall try to show, by what seems to me an unimpeachable mode of reasoning, that, if we adopt Fresnel's theory of a stationary æther, supposing also that a material system can have a uniform translation with constant velocity v without changing its dimensions, we must surely expect the result that was predicted by Maxwell.

Let us introduce a system of rectangular axes of co-ordinates fixed to the material system, the axis of x being in the direction of the motion. Then, with respect to these axes, the æther will flow with the velocity $-v$. The progress of waves of light, relatively to them, may be traced by means of Huygens's principle; for this purpose it suffices to know the form and position of the elementary waves. For the sake of generality I shall suppose the propagation to take place in a material medium of refractive index μ, so that, if c is the velocity of light in the æther, the velocity in the medium when at rest would be c/μ. The elementary wave formed in the time dt around a point P will be a sphere of radius $(c/\mu)dt$, of which the centre P′ does not, however, coincide with P, the line PP′ being in the direction opposite to that of OX, and having the length $(v/\mu^2)dt$ (Fresnel's coefficient).

If Q is any point on the surface of the sphere, PQ can be considered as an element of a ray of light, and $w = \mathrm{PQ}/dt$ will be the velocity of the ray. Confining ourselves to terms of the second order, *i.e.* of the order v^2/c^2, and denoting by δ the angle between the ray and OX, we have

$$\frac{1}{w} = \frac{\mu}{c} + \frac{v}{c^2}\cos\delta + \frac{v^2}{2\mu c^3}(1+\cos^2\delta) \quad . \quad . \quad (1)$$

Now, let A and B be points having fixed positions in the material system. The course s of a ray of light passing from A to B will be determined by the condition that the integral

$$\int \frac{ds}{w} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

is a minimum. Using the above value of $1/w$, it is easily shown that, if quantities of the second order are neglected, the course of the ray is not affected by the translation v, so that, if L_0 is the path of the ray in the case $v = 0$, and L the real path, these lines will be distant from each other to an amount of the second order only. Hence, if in the case of a translation v we calculate by means of (1) the integral (2), both for L and L_0, the two values will differ by no more than a quantity of the fourth order; indeed, since the integral is a minimum for L, the difference must be of the second order with respect to the distances between L and L_0, and these distances are already of the second order of magnitude.

It is seen in this way that, so long as we neglect terms of an order higher than the second, we may replace

$$\int_{L} \frac{ds}{w} \text{ by } \int_{L_0} \frac{ds}{w},$$

an argument that must not be overlooked in the theory of the experiment. On the ground of it we shall commit no error if, in determining the paths L_1 and L_2 of two rays that start from a point A, and are made to interfere at a point B, we take no account of the motion of the apparatus. The change in the difference of phase produced by the translation will be given by the difference between the values which the integral

$$\int \frac{v^2}{2\mu c^3}(1+\cos^2\delta)\,ds$$

takes for the lines L_1 and L_2 so determined. If, along the first of them, $\cos^2\delta = 1$, and along the second $\cos^2\delta=0$, and $\mu=1$, the change will be the same as would be produced by a lengthening of L_1 in the ratio of 1 to $1+v^2/2c^2$. As no displacement of the fringes has been observed, we are led to the well-known hypothesis of a contraction of moving bodies in the direction of translation, in the ratio of 1 to $1-v^2/2c^2$.

We could now try to extend the above considerations to cases in which v/c, though always below 1, is no longer a small fraction. This would require somewhat lengthy calculations, into which, however, we need not enter here, because we know by the theory of relativity that the true value of the coefficient of contraction is $\sqrt{1-v^2/2c^2}$. I may remark here that there can be no question about the reality of this change of length. Suppose that, in studying the phenomena, we use a system of rectangular co-ordinates x_1, x_2, x_3, and a time t, and that in this system the velocity of light is c in all directions. Further, let there be two rods, I. and II., exactly equal to each other, and both placed in the direction of x_1, I. at rest in the system of co-ordinates, and II. moving in the direction of its length with a velocity v. Then, certainly, if the length of a rod is measured by the differences of the values which the co-ordinate x_1 has at the two ends at one and the same instant t, II. will be shorter than I., just as it would be if it were kept at a lower temperature. I need scarcely add that if, by the ordinary transformation of the theory of relativity, we pass to new co-ordinates x_1', x_2', x_3', t' in such a manner that in this system the rod II. is at rest, and if now we measure the lengths by the difference between the values of x_1' which correspond to a definite value of t', I. will be found to be the shorter of the two.

The question arises as to how far the dimensions of a solid body will be changed when its parts have unequal velocities, when, for example, it has a rotation about a fixed axis. It is clear that in such a case the different parts of the body will, by their interaction, hinder each other in their tendency to contract to the amount determined by $\sqrt{1-v^2/c^2}$. The problem can be solved by the ordinary theory of elasticity, provided only that this theory be first adapted to the principle of relativity. Indeed, we can still use Hamilton's principle:—

$$\delta\int_{t_1}^{t_2}dt\int(\mathrm{T}-\mathrm{U})d\mathrm{S}=0 \quad . \quad . \quad . \quad . \quad (3)$$

(dS, element of volume; T, kinetic, and U, potential, energy, both per unit of volume), if, by some slight modifications, the integral is made to be independent of the particular choice of co-ordinates. That this can be done, even in the general theory of relativity (theory of gravitation), is due to the possibility of expressing the length of a line-element in the four-dimensional space x_1, x_2, x_3, x_4 $(x_4=t)$ in "natural units"—*i.e.* in such a manner that the number obtained for it is the same whatever be the co-ordinates chosen—and of measuring angles in a similar way. As is well known, the length ds of a line-element is given by the formula:—

$$ds^2=\Sigma(ab)g_{ab}dx_a dx_b, \quad . \quad . \quad . \quad . \quad (4)$$

where the ten quantities g_{ab} $(g_{ab}=g_{ba})$ are the gravitation potentials, and the angle δ between two elements is determined by

$$\cos\delta\, ds\, d's=\Sigma(ab)g_{ab}dx_a d'x_b \quad . \quad . \quad . \quad (5)$$

In the sums, each of the indices a and b is to be given the values 1, 2, 3, 4. When the value 4 is excluded, as will be the case in some of the following formulæ, a Greek letter will be used for the index.

We can also find an invariant value l for the distance between two material particles P and P′ infinitely near each other. To this effect we have to consider the word-lines L and L′ of these particles in the space x_1, x_2, x_3, x_4. Let Q be the point of L corresponding to the chosen time x_4, and Q′ a point of L′ such that QQ′ is at right angles to L. Then the length of QQ′, determined by means of (4), will be the value required. Similarly, if P″ is a third particle, infinitely near P and P′, and Q″ the point of its word-line so situated that QQ″ is perpendicular to L, the angle P′PP″ will be taken to be the angle between the elements QQ′ and QQ″ determined according to (5).

As to the co-ordinates x_1, x_2, x_3, x_4, it may be recalled that, in a field free from gravitation, they may be chosen in such a manner (x_1, x_2, x_3 being at right angles to each other) that the velocity of light has the constant magnitude c; the potentials g_{ab} will in this case have the values

$$g_{11}=g_{22}=g_{33}=-1,\ g_{44}=c^2,\ g_{ab}=0 \text{ for } a\neq b.$$

These may be called the normal values of the potentials, and a system of co-ordinates for which they hold a normal system.

Let us now consider a solid body M, and let us first conceive it to be placed in a normal system of co-ordinates (S_0), and to be at rest in that system, free from all external forces. The body may then be said to be in its natural state, and its particles may be distinguished from each other by their co-ordinates ξ, η, ζ with respect to three rectangular axes fixed in the body. In all that follows, these quantities will be constant, and so will be the mass $\rho d\xi d\eta d\zeta$ of an element, ρ being the density in the natural state.

We shall now suppose the body to be placed in a system of co-ordinates x_1, x_2, x_3, x_4 (S), not necessarily normal, and to have some kind of motion in that system. It is this motion, in which x_1, x_2, x_3 will be definite functions of ξ, η, ζ, and x_4, which we want to determine by means of Hamilton's principle properly modified.

In order to get the new U, I shall introduce the dilatations ξ_ξ, η_η, ζ_ζ, and shearing strains ξ_η, η_ζ, ζ_ξ, with respect to the axes ξ, η, ζ. These quantities are defined as follows:—

Let P, P′ be the particles ξ, η, ζ, and $\xi+d\xi$, η, ζ, and let l be their distance in the state considered (system S), and l_0 their distance in the natural state (system S_0), these distances being both determined in the manner specified in what precedes. Then

$$\xi_\xi = (l - l_0)/l_0.$$

Again, if P″ is the particle ξ, $\eta + d\eta$, ζ, and if the angle P′PP″, calculated as stated before, has in the two cases the values δ and $\delta_0 (= \frac{1}{2}\pi)$, we shall have

$$\xi_\eta = \delta_0 - \delta.$$

The six deformations ξ_ξ . . . will be considered as infinitely small. In the problem we have in view, they are of the order of magnitude v^2/c^2, so that our final result will be correct to that order.

If we put

$$U = A(\xi_\xi^2 + \eta_\eta^2 + \zeta_\zeta^2) + \tfrac{1}{2}B(\xi_\xi + \eta_\eta + \zeta_\zeta)^2 + \tfrac{1}{2}A(\xi_\eta^2 + \eta_\zeta^2 + \zeta_\xi^2), \quad . \quad (6)$$

the well-known expression for the potential energy of an isotropic elastic body, U will be invariant for any change of co-ordinates.

As to the kinetic energy T, it is to be replaced by an expression containing $\rho \frac{ds}{dt}$. Finally, we must write, instead of (3),

$$\delta \int_{t_1}^{t_2} \int \left(-c\rho - \frac{1}{c} U \right) \frac{ds}{dt} \, dt \, d\xi \, d\eta \, d\zeta = 0.$$

We have still to add the formulæ that are found by working out the above definitions of ξ_ξ, ξ_η, etc., viz. :—

$$\xi_\xi = -\tfrac{1}{2}\Sigma(\alpha\beta) g_{\alpha\beta} \frac{\partial x_\alpha}{\partial \xi} \frac{\partial x_\beta}{\partial \xi} + \frac{\left[\Sigma(\alpha\beta) g_{\alpha\beta} v_\beta \frac{\partial x_\alpha}{\partial \xi} \right]^2}{2\Sigma(ab) g_{ab} v_a v_b} - \tfrac{1}{2},$$

$$\xi_\eta = -\Sigma(\alpha\beta) g_{\alpha\beta} \frac{\partial x_\alpha}{\partial \xi} \frac{\partial x_\beta}{\partial \eta} + \frac{\Sigma(\alpha\beta) g_{\alpha\beta} v_\beta \frac{\partial x_\alpha}{\partial \xi} \cdot \Sigma(\alpha\beta) g_{\alpha\beta} v_\beta \frac{\partial x_\alpha}{\partial \eta}}{\Sigma(ab) g_{ab} v_a v_b}$$

(v_1, v_2, v_3 are the components of the velocity, and $v_4 = 1$).

In our problem the body is supposed to move in a normal system of co-ordinates. By this our formulæ simplify to[1]

$$\delta \int_{t_1}^{t_2} \int \left(-c^2\rho - U \right) \left(1 - \frac{v^2}{c^2} \right)^{\frac{1}{2}} dt \, d\xi \, d\eta \, d\zeta = 0, \quad . \quad (7)$$

$$\xi_\xi = \tfrac{1}{2}\Sigma(\alpha) \left(\frac{\partial x_\alpha}{\partial \xi} \right)^2 + \frac{\left[\Sigma(\alpha) v_\alpha \frac{\partial x_\alpha}{\partial \xi} \right]^2}{2(c^2 - v^2)} - \tfrac{1}{2},$$

$$\xi_\eta = \Sigma(\alpha) \frac{\partial x_\alpha}{\partial \xi} \frac{\partial x_\alpha}{\partial \eta} + \frac{\Sigma(\alpha) v_\alpha \frac{\partial x_\alpha}{\partial \xi} \cdot \Sigma(\alpha) v_\alpha \frac{\partial x_\alpha}{\partial \eta}}{c^2 - v^2}$$

[1] If in (7) we replace $(1 - v^2/c^2)^{\frac{1}{2}}$ by $1 - v^2/2c^2$, omitting the constant term $-c^2\rho$ and neglecting $U.v^2/2c^2$, we are led back to the ordinary formula (3).

When applied to a revolving body, these equations will enable us to determine the deformation that is produced, wholly independently of the theory of relativity, by centrifugal force, a deformation that will in reality far surpass the changes we want to consider. To get free from it we can consider the ideal case of a "rigid" body—*i.e.* a body for which the moduli of elasticity A and B in (6) are infinitely great. The centrifugal force will then have no effect on the dimensions, but the changes required by the theory of relativity will subsist. The assumption has also the advantage of simplifying the calculations; indeed, since U becomes infinitely great, the term $-c^2\rho$ in (7) may be omitted.

I have worked out the case of a thin circular disc rotating with constant speed about an axis passing through its centre, at right angles to its plane. The result is that, if v is the velocity at the rim, the radius will be shortened in the ratio of 1 to $1 - \frac{1}{8}\frac{v^2}{c^2}$. The circumference changing to the same extent, its decrease is seen to be exactly one-fourth of that of a rod moving with the same velocity in the direction of its length. That there would be a smaller contraction was to be expected; indeed, the case can be compared to what takes place when a hot metal band is fitted tightly around a wheel and then left to cool.

At first sight our problem seems to lead to a paradox. Let there be two equal discs A and B, mounted on the same axis, A revolving and B at rest. Then A will be smaller than B, and it must certainly appear so (the discs being supposed to be quite near each other) to any observer, whatever be the system of co-ordinates he chooses to use. However, we can introduce a system of co-ordinates S′ revolving with the disc A; with respect to these it will be B that rotates, and so one might think that now this latter disc would be the smaller of the two. The conclusion would be wrong because the system S′ would not be a normal one. If we leave S for it, we must at the same time change the potentials g_{ab}, and if this is done the fundamental equation will certainly again lead to the result that A is smaller than B.

The Geometrisation of Physics, and its Supposed Basis on the Michelson-Morley Experiment.

By SIR OLIVER LODGE, F.R.S.

SO much has been written about the Michelson-Morley experiment that it would be needless to refer to it here, had it not been interpreted by philosophic writers in an interesting but over-violent and, as some think, illegitimate manner. Historically it really does lie at the root of the remarkable attempt which is being made to geometrise physics, and to reduce sensible things like weight and inertia to a modification of space and time. The work of great Geometers has been pressed into the service, and a differential-invariant scheme of expression has been utilised to do for physics in general, and especially for gravitation, what Maxwell's equations did for electric and magnetic forces. The prominent merit of these equations is that they replace any apparent predilection for forces acting at a distance, by explicit recognition of a modified medium (or at least a modified space) in contact with the accelerated particle.

The beauty and ingenuity of this scheme, and of the reasoning associated with it, are apt to overpower the judgment at times, and to lead to pseudo-philosophic conclusions which are not really justified, and some of which are repugnant to common-sense. It is scarcely wise to seek to interpret physically every link in a chain of mathematical reasoning. If the chain is coherent and if the terminal hooks are firm—that is, if the end results are intelligible and verifiable—no more need be expected from any system of equations. The astonishing thing is that statements of such extensive generality can be written in so compact a form, and that so considerable a range of experience can be summarised in terms of a pure hypergeometry, even though that be of a complex character.

It is undeniable that mathematicians, with a self-denying ordinance about coefficients, can thus attain remarkable criteria, and are able to anticipate definite results; but we need not seek to engraft their modes of expression on the real world of physics. We need not consider realities superseded, because a system of pure space and time can be devised which can formulate, and be consistent with, the movements observed by ordinary men and animals. What we observe is not motion and position alone: a wealth of colour, form, and beauty is also within our ken, and will not readily evaporate into a geometrical modification of empty space.

The Relativity argument is based on a policy of exclusion. It rejects everything that seems unnecessary; it dispenses with many of our long-standing conceptions; and accordingly is hailed as a simplification. The first simplification was the denial of any test for motion through a continuous fundamental medium, and a consequent ignoring of such a medium. The second step was to eliminate gravitational and other forces, with further denial of a power of discrimination between different kinds of acceleration. A third simplification, and further introduction of coefficients, enabled electro-magnetic forces to be similarly eluded. And if our conceptions permit of any further simplification, perhaps the additional properties of matter studied by Chemists and Biologists and Artists may be extruded too, and the rich fullness of the universe be impoverished into a mental abstraction.

To summarise, then :—

In such a system there is no need for Reality; only Phenomena can be observed or verified : absolute fact is inaccessible. We have no criterion for truth; all appearances are equally valid; physical explanations are neither forthcoming nor required; there need be no electrical or any other theory of the constitution of matter. Matter is, indeed, a mentally constructed illusion generated by local peculiarities of Space. It is unnecessary to contemplate a continuous medium as a universal connector, nor need we try to think of it as suffering modification transmitted from point to point from the neighbourhood of every particle of gravitational or electrified matter: a cold abstraction like a space-time-manifold will do all that is wanted, or at least all that the equations compel. And, as a minor detail, which will bring us to the point, it is not necessary to invoke a real FitzGerald contraction in order to explain the result of the Michelson Experiment.

The Experiment.

With this prelude, which merely summarises a great deal more that in time I wish to say, let us proceed to the M.M. Experiment and recall attention to what it really does demonstrate rather than to what it is too often imagined to prove.

Take a horizontal square slab of stone (or wood), float it above an annular trough of mercury so that it can be steadily turned round a vertical axis. Fix mirrors to its surface, so arranged that a beam of light, split into halves, can be sent, one half to and fro lengthways, and the other half to and fro breadthways, each half travelling an equal distance as fixed by the slab. Reunite the two half-beams, observe the interference bands so formed, and see if they shift in a periodic manner during a leisurely rotation of the stone and observer through all azimuths.

If light is really a wave and not a projectile motion, and if we are living in a virtual drift of æther due to our real orbital motion through that medium, and if the stone or other material of the slab preserves and determines unalterably the actual distances travelled by the two half-beams of light in the interval between their split and their reunion—then the bands should undergo a sinuous shift, with amplitude representing a lag of the order 10^{-8}, as the stone revolves.

But, on the electrical theory of matter, cohesion is a residual chemical affinity or electrostatic attraction; and such attraction is known to be modified electrokinetically if the charged atoms are in rapid motion through the dielectric medium; hence it becomes not only possible but likely that the dimensions of the slab will change if we are moving through the æther; the square being subject to a slight distortion. And the change metrically to be expected, in accordance with electrical theory, is found on examination to be also of the order 10^{-8}, and in fact was ultimately shown by Larmor to be of a precisely compensating character. ("Æther and Matter," 1900. p. 175.)

The fact is that the lines of force on an isolated charged sphere redistribute themselves, if it be moving through the æther, as if it had become a stationary oblate spheroid with axis in the direction of motion. Such a spheroid becomes the static representation of a moving sphere, and may be held to take its place as the most symmetrical figure; for the only way in which we can infer the virtual shape of an electron is by the distribution of its field.

Æther being incompressible, I expect that the change is really a pure constant-volume distortion, consisting of a pair of lateral extensions and a longitudinal contraction, as suggested in my B.A. address "Continuity," 1913, in the Birmingham volume, p. 25 (or in a separate publication by Dent and Son, pp. 58 and 111). But all that is significant for present purposes is the ratio of the longitudinal to the lateral change—a ratio commonly spoken of as the FitzGerald or FitzGerald-Lorentz contraction.

It is customary to consider this as only a longitudinal shrinkage, but it is just as easy to allow for a possible lateral change too:—

The velocity of light through the medium being always c, and the speed of the light-conveying medium relatively to the matter of the block being v, the effective or resultant speed for the to-and-fro cross-current light-journey is $\sqrt{(c^2-v^2)}$, while for the up- and down-stream journeys the effective speeds are $(c-v)$ and $(c+v)$ respectively.

The intended perpendicular distances marked out on the slab being both x, the distance along-stream becomes, say, βx (whichever side of the slab gets periodically into that position as it rotates), and the distance across-stream may be called γx; so the respective single journeys are

$$\text{(along)} \quad \beta x = (c-v)t_1 = (c+v)t_2$$
$$\text{(across)} \quad \gamma x = \sqrt{(c^2-v^2)}t_3.$$

The observation does not consist in measuring either t_1 or t_2 or t_3; nor is even x measured with precision. The whole object of the experimenter is to measure the small excess,

$$t_1 + t_2 - 2t_3,$$

to express it as a fraction of wave length, and to compare it with the distance $2x$. Repeated observations show that the excess is actually zero. And with this additional datum,

$$t_1 + t_2 = 2t_3,$$

it is mere algebra to reckon that the necessary effective contraction is

$$\beta/\gamma = \sqrt{(1-v^2/c^2)};$$

while if we choose to add the constant volume relation, $\beta\gamma^2 = 1$, we get also

$$\gamma = (1-v^2/c^2)^{-\frac{1}{6}}.$$

The experiment therefore verifies the FitzGerald contraction, and tends to confirm the electrical theory of matter.

I was interested, when visiting the University of Chicago last winter, to find that Prof. Michelson himself was perfectly satisfied with this sort of view of his experiment, and did not consider that its interpretation necessitated any revolutionary considerations. The FitzGerald contraction is a peculiarity which could scarcely have been detected in any other way, since it is really an affair of the æther—the connecting medium in which all molecules are embedded—and affects every kind of matter to the same extent.

An objection has been raised, with apparent seriousness, that this contraction cannot be real, since, if it were, the rim of a spinning-wheel would contract more than the spokes, and so the ratio of circumference to diameter would not be π. This is an instructive and rather humorous example of the prevalent tendency to control physics by geometry. We might argue similarly that the rim of a wheel could not be a fraction of a degree cooler than the spokes; and it might be held—indeed it has been held—that the state of strain in an actual rotating wheel or disc would require non-Euclidean geometry to express it. If the propositions of geometry require physical measurements to sustain them, they can scarcely be of the kind we have been accustomed to associate with the name of Euclid. And if a special geometry has to be invented in order to account for a falling apple, even Newton might be appalled at the complications which would ensue when really difficult problems are tackled. Nevertheless, that is the kind of geometry to which relativity introduces us—a geometry based on hypothetical laboratory measurements with scales and clocks, and one the propositions of which can be interfered with by metrical observations. It is therefore sometimes called a "natural" geometry, free from metaphysics; it might equally well be called an abstract sort of theoretical physics, and not geometry at all.

Relativity Explanation of the Experiment.

It is well known that the simple interpretation above given of the M.M. experiment is not palatable to relativists; they consider that it is a forced and arbitrary explanation, and that they can account for the M.M. result more naturally by employing a geometrical device and by applying certain general hypotheses. The Principle of simple relativity is that a transformation to uniformly moving axes can make no difference to anything essential; and the accompanying obsession is that no observer can detect any apparent change in the velocity of light.

In order to apply these principles, the method adopted by a Relativist is to take two observers instead of one, to supply them with personal clocks and measuring rods, and then to make one of them fly through the laboratory at speed v; thus rendering accurate measurement rather difficult for him, and introducing some confusion into his ideas of space and time—especially as he is not to be allowed to know that he is moving. He may be at rest in the æther, but everything not attached to him or to his medium will be rushing along; accordingly objects will appear to be contracted, and all clocks but his own will seem to go slow.[1] The only thing

[1] It is not easy to explain without symbols why earthbound clocks should appear to go slow to an aviator, and an aviator's clock appear to go slow to a man on the ground. The plain man would think that they would both appear to go fast during approach, and slow during recession; but the meaning is not so simple as that. Nor is it because a pendulum has lengthened, or anything physical or real of that sort. The argument appears to be that the other man's clock must be estimated as relatively slow, by each of two observers moving relatively to each other, because otherwise they could measure different velocities of light; which, though not repugnant to common-sense, is contrary to the basic Principle of Relativity.

unaltered is speed, for he is allowed to compensate every confusion about space by an equal opposite confusion about time. However, he is provided with an instantaneous camera for taking snapshots which he can afterwards study, and he does his best; he makes his observations of times and distances, and records them with dashed letters. Meanwhile the other more comfortably situated observer, attached to the slab and the laboratory furniture (who also considers himself at rest, though the first man may think of him as rushing through the æther), records, undashed, the readings of his peculiar instruments too.

A relativist, not caring in the least which or whether either of these sets of measurements has any absolute meaning, but assuming them to be made accurately, applies the transformation of Lorentz and Larmor for change of co-ordinates between sets of axes moving relatively to each other; and thereby finds that if the laboratory readings are x and t, while the flying man's readings are x' and t' (each being supposed to have a local space and time of his own, absolute space and time having no meaning), the following relations must hold—

$$x' = \frac{x - vt}{\sqrt{(1 - v^2/c^2)}}; \quad t' = \frac{t - vx/c^2}{\sqrt{(1 - v^2/c^2)}}.$$

From these simple but important, and indeed fundamental, equations it comes out that if $x'/t' = c$ for the flying man. then $x/t = c$ for the other observer likewise. So the result is just as if nothing at all was moving, except light, and in fact as if bodily motion through the light-conveying medium were meaningless. Hence everybody should be satisfied, without any appeal to, or confirmation of, any physical theory whatever. The null (or dull) result of the experiment now requires no explanation; there is no need even to emphasise the double to-and-fro journey of the light; single journeys serve; for the apparent speed of light is (really, has been assumed) the same in all directions, no matter what it be referred to. Distances and times may appear different to different observers, but they are arbitrary or conventional appearances at best, and they tend to compensate each other.

Hence arises the $r = ct$ and $r' = ct'$ superstition, about the concentricity of a wave front round each one of a group of observers initially at the origin however much they may have scattered since; because, apart from gravitation, $x^2 + y^2 + z^2 - c^2t^2$ must be independent of axes of reference; or, what is the same thing in our simple case,

$$\frac{x - ct}{x' - ct'} = \frac{x' + ct'}{x + ct} = \text{constant} = \sqrt{\frac{c - v}{c + v}}.$$

And the other peculiarities of the simpler theory of relativity immediately follow: some of them very surprising and interesting.

For instance, take the composition of motions: If a thing is moving with speed $u = x'/t'$, relatively to an origin which itself is moving in (say) the same direction with speed v referred to a fixed origin, then the resultant speed $w = x/t$, referred to the same fixed origin, will be obtained by aid of the above transformation for moving axes reduced to relative rest—

$$x = \beta(x' + vt'); \ t = \beta(t' + vx'/c^2);$$

whence we get

$$w = \frac{x}{t} = \frac{u + v}{1 + uv/c^2}$$

a curious expression for the combined velocities. [Likening it to a rotation of axes, with $v/c = \tanh\theta$, the summation is not $\tanh\theta_1 + \tanh\theta_2$ but $\tanh(\theta_1 + \theta_2)$.] It gives simple summation for slow speeds, and an unattainable maximum c for high speeds. If either or both of the component velocities attain the magnitude c, the resultant w attains the same maximum, and cannot exceed it. But the most notable property of this expression is that it gives practically the same expression as Fresnel's æther-intuition gave, for light travelling down a stream of water—an expression verified by Fizeau's famous experiment. For let the speed u be that of light inside a dense material medium, say $c \div \mu$, and let the material medium be itself travelling in the same direction at speed v, then the resultant speed of the light would be, by the above expression,

$$w = \frac{c^2 + \mu vc}{\mu c + v},$$

or, what is the same thing,

$$w = c/\mu + v.\frac{1 - 1/\mu^2}{1 + v/\mu c}$$

And this, to a high degree of approximation, is practically identical with the Fresnel-Fizeau result, viz.:

$$w = c/\mu + v(1 - 1/\mu^2).$$

That such a result—which was supposed to give some kind of information about the behaviour of æther inside dense matter—can be obtained irrationally by a simple geometrical device, is surely surprising.

Again, the variation of the mass factor in momentum, which was originally predicted from the electrical theory of matter and afterwards verified, exhibits itself as an outcome of the relativity expression without any physical theory at all. The inertia of an electric charge, and indeed of all energy, seems to come out likewise. Light has a mass-factor, but not a conserved or invariable one, while matter has both a fixed and a variable term in its factor; which is a notable and suggestive pair of facts.

From the point of view of the above relativity composition of velocities, the Michelson-Morley result is obvious; for if the speed u under observation is already c, as it is in that experiment, it is useless to compound another velocity, $\pm v$, with it; because, if that is the law of composition, the resultant velocity still comes out c, no more and no less.

It may be said that whereas most experimenters assume an absolute time, the relativist assumes one absolute unattainable or unexceedable velocity. That is the assumption on which his whole argument is based; and, as an instinctive intuition, there may be a foundation for it (see below), and even for the further assumption that the fundamental absolute velocity is either equal to, or of the same order as, the velocity of light.

It must not be supposed however that the Michelson-Morley experiment substantiates the structure thus begun upon it. It does not really prove that the velocity of light in a moving medium is the same in all directions; that is a gratuitous but fundamental hypothesis, not really based on any experiment—certainly not on one which only deals with to-and-fro journeys over matter-fixed distances. Nevertheless, whether or not this foundation-stone of Relativity is well and truly laid, the structure built over it is of remarkable interest; and possibly can sustain itself by its own consistency, and by its attachments to other facts, even if it be admittedly arched over the particular experiment on which it was originally supposed to be founded.

A Few Remarks on the More General Theory of Relativity.

The consistency of all these things, including the conservation of energy and momentum, with simple relativity, amply accounts for the enthusiasm with which brilliant mathematicians, untrammelled by a sense of physical reality, have absorbed and developed the idea.

Indeed, as we know, Einstein was enticed to go on and try a transformation to accelerated axes also, to identify gravitation and inertia, to ally both with the so-called centrifugal force, and to reduce them all to a still more elaborate geometry, in which the Lorentz transformation is inadequate, and Euclidean propositions are superseded. He found ready to his hand a recondite scheme, provided for other and less worldly purposes by Gauss and Riemann; but, to make use of it, he had to introduce a fresh agnostic principle, a Principle of Equivalence. He must assume that we cannot discriminate between a whirling table and a gravitational field; that we have no criterion between a falling apple and a rising Earth; and that it is only prejudice which makes us feel assured about a rotating Earth, and unwilling to contemplate a diurnally revolving star. Geometrically they are all the same; and a suitable space-time system can be devised, and expressed in equations, which will account for, or at least express, most things observed in astronomy, and some additional things more allied with physics.

Now we must admit that if we are permitted to discard relativity as a *philosophy* and accept it as a *method*, the form of the most striking of its equations is advantageous, and represents an advance in symbolism, quite apart from any unphysical contributions to its origin and any lack of legitimacy about its birth. For the weight of an apple must be really, as it always has been hypothetically and vaguely, attributable to a gravitationally modified æther pressing down on each particle. Similarly the path of a planet from instant to instant can be expressed more intimately by a variational equation, involving always the next step, than by an action-at-a-distance formula, or by a merely kinematic summary which integrates the result over an entire orbit. But this powerful and ingenious method of research can be interpreted, in words, so as to suggest nothing more than a warping of an unreal emptiness—a sort of return to Descartes' vortices without their imagery, a rejection of Copernicus and Galileo and Newton.

Whereas what is really wanted for a truly Natural Philosophy is a supplement to Newtonian Mechanics, expressed in terms of the medium which he suspected and sought after but could not attain, and introducing the additional facts, chiefly electrical—especially the fact of variable inertia—discovered since his time. Such a philosophy would insist that the specific state of the medium throughout a gravitational field must be the immediate consequence, indeed the absolute essence, of the existence of each material particle; their separate potentials being combined by simple addition without any second-order complications. Equally an electric field must be part of the actual constitution of an electron, and inseparable from it: though the compounding of electric fields need not be so simple a matter, since charges in proximity do interfere with each other.

If we could understand the structure of the particle, in terms of the medium of which it is composed, and if we knew the structure of the rest of the medium also, so as to account for the potential stress at every point—that would be a splendid step, beyond anything accomplished yet. But that the particle is a singularity in the medium, and that its inertia and gravitational field are essential to, and part of, its very existence, must certainly be true; and this is what the Einstein theory, in its own peculiar geometrical unphysical way, has grasped. There are not half a dozen diverse but interlocked things in Nature: there is one definite quiescent medium, full of exceedingly fine-grained turbulent energy, with consequent properties which, when unravelled, will supply the key to all the non-mental phenomena occurring in it. Provided always that the locking up of small regions of this turbulence, not merely in the travelling form of light-waves, but in the potentially stationary form of electrons, can also be explained and understood.

Relativity, as a consecutive point-to-point method of arriving at results, is a first step towards this ideal, but it is not a Newtonian step; it is rather a blindfold method of investigation, like Entropy and Least Action.

The Fundamental Velocity.

To make a philosophic scheme of existence complete, more than the expression of a static instant is required, there must be duration likewise: the universe is not merely a Being but truly a Becoming; Time has to be associated with Space. This can only be done by a velocity factor of some kind; but to arrive at an appropriate factor, relativists have not dived down into the æther, as someone must ultimately dive, and dissected out the intrinsic speed of its turbulence—which is really the fundamental velocity in existence—they have utilised the more obvious and conspicuous *consequence* of this fundamental speed, viz. the uniform velocity with which the æther can convey a great variety of signals. Indeed their attachment to appliances like clocks and rods has led them to pay almost undue reverence to the æther's power of transmitting waves at a high and otherwise unattainable speed. It is true that these waves are among our methods of receiving and conveying information; but too much attention may be paid to the mere reception of information; and what is spoken of as "warping" is not limited to space alone. For some philosophers speak as if the duration of an event could be extended by merely delaying the reception of the news of its end; as if we could prolong a man's life by evading the tidings of his death, and might be entitled to say, without absurdity, that a man who died at seventy had lived seventy-one years and a lot of miles, if we had travelled so far that the messenger took a year to reach us. That such things can be gravely uttered is surely a tribute to the beauty and complexity of the mathematical scheme which can temporarily so warp the judgment even of the most competent.

If I am wrong in this I share a fraction of rashness with the admirable audacity of Einstein in the *Weltmacht oder Niedergang* sort of attitude which he takes up about his predicted shift of spectral lines. I feel a doubt whether those lines will be found shifted—at least when the observation is made outside a strong gravitational field—but I should be quite content either way, and would not think of asking anyone to abandon the method of relativity on that account.[2]

For undoubtedly general relativity, not as a philosophic theory but as a powerful and comprehensive method, is a remarkable achievement; and an ordinary physicist is full of admiration for the equations and the criteria, borrowed from hyper-Geometers, applied by the genius of Einstein, and expounded in this country with unexampled thoroughness and clearness by Eddington. But, notwithstanding any temptation to idolatry, a physicist is bound in the long run to return to his right mind; he must cease to be influenced unduly by superficial appearances, impracticable measurements, geometrical devices, and weirdly ingenious modes of expression; and must remember that his real aim and object is absolute truth, however difficult of attainment that may be, that his function is to discover rather than to create, and that beneath and above and around all Appearances there exists a universe of full-bodied, concrete, absolute, Reality.

[2] Since the above paragraph was in type a Circular, dated January, 1921, has reached me from Prof. Slipher, of the Lowell Observatory at Flagstaff, Arizona, recording an extravagant rate of recession—something like a thousand miles a second—for two specified nebolæ, presumably of the spiral class. But both nebulæ are reported to have large and brilliant nuclei; and if the concentration of their aggregate mass were sufficient—that is, if their M/R or $\rho\kappa_2$ were some two or three thousands of times greater than that of our sun, and therefore of a totally different order from that of our stellar system—the observation could be interpreted, not as recession, but as an Einstein shift of spectral lines.

Electricity and Gravitation

By PROF. H. WEYL.

[Translated by Dr. Robert W. Lawson.]

MODERN physics renders it probable that the only fundamental forces in Nature are those which have their origin in gravitation and in the electromagnetic field. After the effects proceeding from the electromagnetic field had been co-ordinated by Faraday and Maxwell into laws of striking simplicity and clearness, it became necessary to attempt to explain gravitation also on the basis of electromagnetism, or at least to fit it into its proper place in the scheme of electromagnetic laws, in order to arrive at a unification of ideas. This was actually done by H. A. Lorentz, G. Mie, and others, although the success of their work was not wholly convincing. At the present time, however, in virtue of Einstein's general theory of relativity, we understand in principle the nature of gravitation, and the problem is reversed. It is necessary to regard electromagnetic phenomena, as well as gravitation, as an outcome of the geometry of the universe. I believe that this is possible when we liberate the world-geometry (on which Einstein based his theory) from an inherent inconsistency, which is still associated with it as a consequence of our previous Euclidean conceptions.

The great accomplishment of the theory of relativity was that it brought the obvious principle of the *relativity of motion* into harmony with the existence of *inertial forces*. The Galilean law of inertia shows that there is a kind of obligatory guidance in the universe, which constrains a body left to itself to move with a perfectly definite motion, once it has been set in motion in a particular direction in the world. The body does this in virtue of a tendency of persistence, which carries on this direction at each instant "parallel to itself." At every position P in the universe, this tendency of persistence (the "guiding field") thus determines the infinitesimal parallel displacement of vectors from P to world-points indefinitely near to P. Such a continuum, in which this idea of infinitesimal parallel displacement is determinate, I have designated as an "affinely connected" one (*affin zusammenhängend*). According to the ideas of Galileo and Newton, the "affine connection" of the universe (the difference between straight and curved) is given by its geometrical structure. A vector at any position in the universe determines directly and without ambiguity, at every other position, and by itself (*i.e.* independently of the material content of the universe), a vector "equal" to itself. According to Einstein, however, the guiding field (*Führungsfeld*) is a physical reality which is dependent on the state of matter, and manifests itself only infinitesimally (as a tendency of persistence which carries over the vectors from one point to "indefinitely neighbouring" ones). The immense success of Einstein's theory is based on the fact that the effects of gravitation also belong to the guiding field, as we should expect *a priori* from our experience of the equality of gravitational and inertial mass. The planets follow exactly the orbit destined to them by the guiding field; there is no special "gravitational force" necessary, as in Newton's theory, to cause them to deviate from their Galilean orbit. In general, the parallel displacement is "non-integrable"; *i.e.* if we transfer a vector at P along two different paths to a point P′ at a finite distance from P, then the vectors, which were coincident at P, arrive at P′ in two different end-positions after travelling these two paths.

The "affine connection" is not an original characteristic of the universe, but arises from a more deeply lying condition of things—the "metrical field." There exists an infinitesimal "light-cone" (*Lichtkegel*) at every position P in the world, which separates past and future in the immediate vicinity of the point P. In other words, this light-cone separates those world-points which can receive action from P from those from which an "action" can arrive at P. This "cone of light" renders it possible to compare two line-elements at P with each other by measurement; all vectors of equal measure represent one and the same *distance* at P. In addition to the determination of measure at a point P (the "relation of action" of P with its surroundings), we have now the "metrical relation," which determines the congruent transference of an arbitrary distance at P to all points indefinitely near to P.

Just as the point of view of Einstein leads back to that of Galileo and Newton when we assume the transference of vectors by parallel displacement to be integrable, so we fall back on Einstein when the transference of distances by congruent transference is integrable. But this particular assumption does not appear to me to be in the least justified (apart from the progress of the historical development). It appears to me rather as a gross inconsistency. For the "distances" the old point of view of a determination of magnitudes in terms of each other is maintained, this being independent of matter and taking place directly at a distance. This is just as much in conflict with the principle of the *relativity of magnitude* as the point of view of Newton and Galileo is with the principle of the *relativity of motion*. If, in the case in point, we proceed in earnest with the idea of the continuity of action, then "magnitudes of condition" occur in the mathematical description of the world-metrics in just sufficient number and in such a combination as is necessary for the description of the electromagnetic and of the gravitational field. We saw above that, besides inertia (the retention of the vector-direction), gravitation was also included in the guiding field, as a slight variation of this, as a whole, constant inertia. So in the present case, in addition to the force which conserves space- and time-lengths, *electromagnetism* is also included in the metrical relation. Unfortunately, this cannot be made clear so readily as in the case of gravitation. For the phenomena of gravitation are easily obtained from the *Galilean principle*, according to which the world-direction of a mass-point in motion follows at every instant the parallel displacement. Now it is by no means the case that the ponderomotive force of the electromagnetic field should be included in our Galilean law of motion, as well as gravitation, for a charged mass-point does not follow the guiding field. On the contrary, the correct equations of motion are obtained only by the establishment of a definite and concrete law of Nature, which is possible within the framework of the theory, and not from the general principles of the theory.

The form of the law of Nature on which the condition of the metrical field is dependent is limited by our conception of the nature of gravitation and electricity in still greater measure than it is by Einstein's general principle of relativity. When the metrical connection alone is virtually varied, the most simple of the assumptions possible leads exactly to the *theory of Maxwell*. Thus, whereas Einstein's theory of gravitation gave certain inappreciable deviations from the Newtonian theory, such as could be tested by experiment, our interpretation of electricity—one is almost tempted to say unfortunately—results in the complete confirmation of Maxwell's laws. If we supplement Maxwell's "magnitude of action" (*Wirkungsgrösse*) by the simplest additional term which also allows of the virtual variation of the "relation of action," we then arrive at *Einstein's laws of the gravitational field*, from which, however, there are two small deviations:

(1) That *cosmological term* appears which Einstein appended later to his equations, and which results in the spatial closure (*Geschlossenheit*) of the universe. A hypothesis conceived *ad hoc* by Einstein to explain the generally prevailing equilibrium of masses results here of necessity. Whereas Einstein has to assume a pre-stabilised harmony between the "cosmological constant" which is characteristic for his modified law of gravitation, and the total mass fortuitously present in the universe, in our case, where no such constant occurs, the world-mass determines the curvature of the universe in virtue of the laws of equilibrium. Only in this way, it appears to me, is Einstein's cosmology at all possible from a physical point of view.

(2) In the case where an electromagnetic field is present, Einstein's cosmological term must be supplemented by an additional term of similar

character. This renders the existence of charged material particles possible without requiring an immense mass-horizon as in Einstein's cosmology.

At first the *non-integrability of the transference of distances* (*Streckenübertragung*) aroused much antipathy. Does not this mean that two measuring-rods which coincide at one position in the universe no longer need to coincide in the event of a subsequent encounter? Or that two clocks which set out from one world-position with the same period will possess different periods should they happen to encounter at a subsequent position in space? Such a behaviour of "atomic clocks" obviously stands in opposition to the fact that atoms emit spectral lines of a definite frequency, independently of their past history. Neither does a measuring-rod at rest in a static field experience a congruent transference from moment to moment.

What is the cause of this discrepancy between the idea of congruent transfer and the behaviour of measuring-rods and clocks? I differentiate between the determination of a magnitude in Nature by "persistence" (*Beharrung*) and by "adjustment" (*Einstellung*). I shall make the difference clear by the following illustration: We can give to the axis of a rotating top any arbitrary direction in space. This arbitrary original direction then determines for all time the direction of the axis of the top when left to itself, by means of a *tendency of persistence* which operates from moment to moment; the axis experiences at every instant a parallel displacement. The exact opposite is the case for a magnetic needle in a magnetic field. Its direction is determined at each instant independently of the condition of the system at other instants by the fact that, in virtue of its constitution, the system *adjusts* itself in an unequivocally determined manner to the field in which it is situated. *A priori* we have no ground for assuming as integrable a transfer which results purely from the tendency of persistence. Even if that is the case, as, for instance, for the rotation of the top in Euclidean space, we should find that two tops which start out from the same point with the same axial positions and encounter again after the lapse of a very long time would show arbitrary deviations of their axial positions, for they can never be completely isolated from every influence. Thus, although, for example, Maxwell's equations demand the conservational equation $de/dt=0$ for the charge e of an electron, we are unable to understand from this fact why an electron, even after an indefinitely long time, always possesses an unaltered charge, and why the same charge e is associated with all electrons. This circumstance shows that the charge is not determined by persistence, but by adjustment, and that there can exist only *one* state of equilibrium of the negative electricity, to which the corpuscle adjusts itself afresh at every instant. For the same reason we can conclude the same thing for the spectral lines of atoms. The one thing common to atoms emitting the same frequency is their constitution, and not the agreement of their frequencies on the occasion of an encounter in the distant past. Similarly, the length of a measuring-rod is obviously determined by adjustment, for I could not give *this* measuring-rod in *this* field-position any other length arbitrarily (say double or treble length) in place of the length which it now possesses, in the manner in which I can at will predetermine its direction. The theoretical possibility of a determination of length by adjustment is given as a consequence of the *world-curvature*, which arises from the metrical field according to a complicated mathematical law. As a result of its constitution, the measuring-rod assumes a length which possesses this or that value, *in relation to the radius of curvature of the field*. In point of fact, and taking the laws of Nature indicated above as a basis, it can be made plausible that measuring-rods and clocks adjust themselves exactly *in this way*, although this assumption—which, in the neighbourhood of large masses, involves the displacement of spectral lines towards the red upheld by Einstein—does not appear anything like so conclusive in our theory as it does in that of Einstein.

The Relativity of Time.

By Prof. A. S. Eddington, F.R.S.

THE philosopher discusses the significance of time; the astronomer measures time. The astronomer goes confidently about his business and does not think of asking the philosopher what exactly is this thing he is supposed to be measuring; nor does the philosopher always stop to consider whether time in his speculations is identical with the time which the world humbly accepts from the astronomer. In these circumstances it is not surprising that some confusion should have arisen.

In many globular clusters there are stars which oscillate in intrinsic brightness; let us select two such stars from different clusters and invite all the astronomers in the universe to measure the true interval of time between the moments of maximum light of the two stars. They must, of course, make whatever measurements and calculations they consider necessary to allow for the finite velocity of light. It may easily happen that the astronomers on Arcturus report that the two maxima were simultaneous; whereas those on the earth report an interval of *ten years* between the same two maxima. There is here no question of observational error; the recognised terrestrial method necessarily gives a discordant result when used on Arcturus, owing to its different motion.

Our first impulse is to blame the astronomers.

Evidently they are not giving us the true time-interval; and now that they are informed of the discordance they ought to give up their out-of-date procedure. But the astronomers reply: "Tell us, then, how we ought to find this 'true time.' By what characteristics are we to recognise it?" No answer has been given. Michelson and others sought in vain for an answer; for if our velocity through the æther could be defined, it would single out one universal system of time-measurement which might reasonably (if somewhat arbitrarily) be called true. Meanwhile the phrase *true time* is a "meaningless noise." It is idle to contest with those who hold that the thing exists and ought to be regarded. "Who would give a bird the lie, though he cry 'Cuckoo' never so?"

The direction of Northampton measured by astronomers at Cambridge is due west; measured by astronomers at Greenwich it is north-west. It is no use to tell them that they must adopt a different plan, and find a "true direction" of Northampton which does not show these discordances. They reply: "We are perfectly aware that there must be discordances, as you call them; but that is in the nature of a relative property like direction; as for this true direction which shall be the same from all stations, we have no idea what you are talking about."

The time determined by astronomers and in general use is thus a fictitious time, or, in the usual phrase, it is *relative* to terrestrial observers. Similarly it has been found that extension in space is also relative. When the Copernican theory led to the abandonment of the geocentric view of the universe, the revolution did not go far enough; it was thought that we could pass to the heliocentric outlook by merely allowing for what in pure geometry would be called a change of origin. Actually a more profound transformation is necessary. For example, the Michelson-Morley experiment is a terrestrial experiment, but its theory is treated from a heliocentric point of view; that is to say, account is taken of the varying orbital motion of the earth; it furnishes a proof of the famous FitzGerald contraction, and much ingenuity has been spent on an electrical explanation of this curious property of matter. Einstein's theory waves this aside with the remark: "Of course, your results appear strange when you describe the apparatus in terms of a space and time which do not belong to it. Your electromagnetic discussion is no doubt valid, but it is leading you away from the root of the matter; the immediate explanation lies in the difference between the heliocentric and geocentric space and time systems."

It was shown by Minkowski that all these fictitious spaces and times can be united in a single continuum of four dimensions. The question is often raised whether this four-dimensional space-time is real, or merely a mathematical construction; perhaps it is sufficient to reply that it can at any rate not be less real than the fictitious space and time which it supplants. Terrestrial observers divide the four-dimensional world into a series of sections or thin sheets (representing space) piled in an order which signifies time; in other words, the enduring universe is analysed into a succession of instantaneous states. But this division is purely geometrical. The physical structure of the enduring world is not laminated in this way; and there is nothing to prevent another observer drawing his geometrical sections in a different direction. In fact, he will do so if his motion differs from ours.

Now it may seem that we have been paying too much deference to the astronomers: "After all, they did not discover time. Time is something of which we are immediately conscious." I venture to differ and to suggest that (subject to certain reservations) time as now understood *was* discovered by an astronomer—Römer. By our sense of vision it appears to us that we are present at events far distant from us, so that they seem to occur in instants of which we are immediately conscious. Römer's discovery of the finite velocity of light has forced us to abandon that view; we still like to think of *world-wide* instants, but the location of distant events among them is a matter of hypothetical calculation, not of perception. Since Römer, time has become a mathematical construction devised to give the least disturbance to the old illusion that the instants in our consciousness are world-wide.

Without using any external senses, we are conscious of the flight of time. This, however, is not a succession of world-wide states, but a succession of events at one place—not a pile of sheets, but a chain of points. Common-sense demands that this time-succession should be essentially different from the space-succession of points along a line. The preservation of a fundamental distinction between timelike succession and spacelike succession is essential in any acceptable theory. Thus in the four-dimensional world we recognise that there are two types of ordered succession of events which have no common measure; type A is like the succession of instants in our minds, and type B is the relation of order along a line in space. Proceeding from the instant "here-now," I can divide the regions of the world into two zones, according as they are reached by a succession of type A (my absolute past and future), or of type B (my absolute "elsewhere"). This scheme of structure is very different from the supposed laminated structure of the older view. Since we believe that this distinction of types A and B corresponds to something in the actual structure of the world, it is likely to determine the various natural phenomena that are observed. Thus it determines the propagation of light, since it is found that the line of a light-pulse is always on the boundary between the two zones above-mentioned. More important still, a particle of matter is a structure which can occupy a chain of points only of type A. Since we are limited by our material bodies, it must be this type of succession which we immediately experience; we are aware of the existence of the other type only by deduction from the indications of our external senses.

Objection is sometimes raised to the extravagantly important part taken by light-signals and light-propagation in Einstein's discussion of space and time. But Einstein did not invent a space and time depending on light-signals; he pointed out that the space and time already in general use depended on light-signals and equivalent processes, and proceeded to show the consequences of this. Turning from fictitious space and time to the absolute four-dimensional world, we still find the velocity of light playing a very prominent part. It is scarcely necessary to offer any excuse for this. Whether the substratum of phenomena is called *aether* or *world* or *space-time,* one requirement of its structure is that it should propagate light with this velocity.

The resolution of the four-dimensional continuum into a succession of instantaneous spaces is not dictated by anything in the structure of the continuum. Nevertheless, it is convenient, and corresponds approximately to our practical outlook on the world; and it is rarely necessary to go back to the undivided world. We have to go back to the undivided world when a comparison is made between the phenomena experienced by observers with different motions, who make the resolution in different directions. Moreover, a world-wide resolution into a space and time with the familiar properties is possible only when the continuum satisfies certain conditions. Are these conditions rigorously satisfied? They are not; that is Einstein's second great discovery. It is no more possible to divide the universe in this way than to divide the whole sky into squares. We have tried to make the division, and it has failed; and to cover up the consequences of the failure we have introduced an almost supernatural agency—gravitation. When we cease to strive after this impossibility—a mode of division which there was never any adequate reason for believing to be possible—gravitation as a separate agency becomes unnecessary. Our concern here is with the bearing of this result on time. Time is now not merely relative, but local. The relative time for an observer is a construction extended by astronomers throughout the universe according to mathematical rules; but these rules break down in a region disturbed by the proximity of heavy matter, and cannot be fulfilled accurately. We can preserve our time-partitions only by making up fresh rules as we require them. The local time for a particular observer is always definite, and is the physical representation of the flight of instants of which he is immediately aware; the extended meshwork of co-ordinates radiating from this is drawn so as to conform roughly to certain rules—so as not to violate too grossly certain requirements which the untutored mind thought necessary at one time. Subject to this, time is merely one of four co-ordinates, and its exact definition is arbitrary.

To sum up, world-wide time is a mathematical system of location of events according to rules which on examination can only be regarded as arbitrary; it has not any structural—and still less any metaphysical—significance. Local time, which for animate beings corresponds to the immediate time-sense, is a type of linear succession of events distinct from a pure spacelike succession; and this distinction is fully recognised in the relativity theory of the world.

Theory and Experiment in Relativity.[1]

By Dr. Norman Campbell.

"SPACE" and "time" are the conceptions of theory, not of laws. They are neither necessary nor useful in the statement of the results of any experiment. The experimental concepts with which, like all theoretical ideas, they are connected are such magnitudes as length, area, volume, angle, period (of a system), or time-interval. The numerical laws of experimental geometry involve two or more "spatial" magnitudes and no other magnitudes; for example, the area of a rectangle is proportional to the product of the lengths of its sides. There are no laws relating "temporal" magnitudes only.

Relativity neither adds to nor subtracts from the collection of spatial and temporal laws. The laws which it explains all involve magnitudes that are not spatial or temporal. And this is fortunate. For the subject has been so completely examined that it is very improbable that any proposed new laws could be true. If relativity predicted anything inconsistent with firmly established experiment, Nature would not devote a special number to discussing it.

It may be objected that relativity does predict new and strange laws; it predicts that the velocity of light in a region remote from material bodies is always the same; and it predicts unfamiliar experiences of observers travelling at great speeds or in the neighbourhood of concentrated mass. But, it may be replied, the measurement of the velocity of light does not involve only spatial and temporal magnitudes; we do not measure that velocity as we do the velocity of a material body; an element of theory is always involved. Again, we do *not* observe any disturbance of geometrical laws in the neighbourhood of the densest bodies we know. And as for Prof. Eddington's observers in aeroplanes travelling with half the velocity of light, no two human

[1] Since it is impossible to make a short article on a large subject anything but a summary, perhaps I may be permitted to refer any reader who is interested to my "Physics: The Elements" for a fuller discussion of many of the questions raised.

beings have smoked, or, if the doctrines of relativity are true, ever will smoke, cigars—let alone make accurate measurements—in such aeroplanes, and afterwards compared their experiences. If we pretend to talk about experiments, let us be sure that we do talk about experiments, and not about something that cannot possibly happen.

However, it may not be useless to ask what would happen if we did find our spatial laws untrue, in the manner suggested, at speeds that can be realised. I suggest that we should make our laws true once more by changing slightly the meaning of the terms in them. The technical terms of science are labels attached to collections of observations that can be grouped into laws, which those terms are used to describe. If we find that the supposed laws are not true, the terms become meaningless; we might abandon them altogether; but generally we discover that, by a slight regrouping of the facts according to the new laws, we can make once more a collection of the facts to which the old term may be applied appropriately to state the new laws in almost precisely the old form.

Consider, for example, the term "simultaneous." Primarily, two events were judged to be simultaneous by direct perception. Using this test and examining a limited range of experience, we found the law that events that are simultaneous to one observer are simultaneous to another. But later we found that the law was not valid for more extended experience, including the sound and flash from a gun. That discovery made "simultaneous" meaningless, and with it all the temporal magnitudes; there was no longer any way of assigning uniquely a numeral to represent the time-interval between two events. So we changed the meaning of "simultaneous," and introduced a "correction" (very complicated, as sound-rangers know); by this means we made "simultaneous" once more the expression of a law, and reproduced our specifications for measuring time-intervals in exactly the old form, but, of course, with rather different content. If we encountered new difficulties when we extended our observations to events in systems moving with great relative speeds, we could, I think, introduce a new "correction" for speed, and reproduce once more the form of our old laws and our old methods of measurement. At any rate, the resulting change of form need not be so great as to cause any appearance of paradox.

I conclude, therefore, that nothing that the most extravagant imagination has suggested so far could make us diverge appreciably from our present spatial and temporal laws. But it is otherwise with our theories. The experimental physicist has a theory of time and space, although he may not be conscious of it. It is based on Cartesian geometry.[2] It likens "space" to an array of black dots in a cubical lattice, and "time" to a series of ticks from a metronome. It connects the position of a body with the individual characteristics of the dots that it "occupies," and the magnitudes length, area, volume with the number of those dots. The time of an event it connects with the individual characteristics of the ticks. The theory explains well some spatial laws, but in some directions it is misleading. Thus it fails to make a distinction between lengths and areas, which (in the last resort) must be measured by the superposition of rigid bodies,[3] and volumes, which cannot be measured by such superposition. It should be noted that the dots and ticks, the "points" and "instants" of mathematically minded philosophers, are purely theoretical ideas. They have no meaning apart from the theory, and, like the position of a hydrogen molecule, cannot be determined by experiment.

Prof. Einstein has altered and expanded this theory. In conjunction with Minkowski, he has altered it by merging the dots and ticks, formerly independent, into a single array of world-points, and by making the arrangement of these points quite different from that of a cubic (or Euclidean) lattice. He has expanded it by introducing the idea of the "natural path" of a body among the points, which enables him to explain the laws of dynamics without the (theoretical) idea of forces. But his propositions still form a theory, and they still contain purely theoretical ideas, which cannot be determined by experiment—the world-point or the infinitesimal "interval," which must be integrated before it can be related to measured magnitudes.

These changes are very disturbing to the experimenter. He wants theories to explain laws. Explanation involves not only the possibility of deducing the laws (for that is easily attained), but also the introduction of satisfactory ideas. In the older types of physical theory this "satisfactoriness" was obtained by means of an analogy between the ideas of the theory and the concepts of some experimental laws. Thus in the older theory of space the points were related in a way analogous to that in which small material bodies can be related. In the new theory this analogy fails. For the mathematician the passage from flat three-dimensional space to curved four-dimensional space is trivial; for the experimenter it is vital, because we do not actually experience any arrangements at all analogous to those of points in such a space. The satisfactoriness of the theory, for those who press it on our attention, is derived, not from material analogy, but from the intrinsic elegance and beauty of the relations involved, the faculty for appreciating which distinguishes the pure mathematician from his fellows.

It is not surprising, therefore, that experimenters have found difficulty in accepting the theory as an ultimate solution of their problem. The old theories explained, because they inter-

[2] It is interesting to notice that, though the theory is sometimes called Euclidean, Euclid had never heard of it. No Greek geometer would have known what you meant if you had told him that space was three-dimensional.

[3] "Rigid bodies" is a label attached to a collection of facts grouped in laws, the laws that make possible the measurement of lengths and areas.

preted in terms of familiar ideas; even to the most revolutionary of mankind, familiarity is a source of some satisfaction. The new theory is based on ideas utterly unfamiliar, and it might be urged that anything based on them must be the precise contrary to explanation. But if we ask why we are so ready to accept theories based on material analogy, we shall find our reason in the fact that such theories have actually turned out to possess the amazing property of predicting unsuspected laws. The theory of relativity also possesses that property. Ought we not to extend, so as to include it, our notions of the proper limits of physical theory, and to rid ourselves of the discomfort of unfamiliarity by the simple process of studying its ideas so closely that they become an integral part of our mental equipment?

It may be asked, Do theories, indeed, aim at nothing but satisfactoriness and prediction? Is not their object rather to discover the true nature of the real world? Such questions must be answered by questions. Do physicists (I say nothing of mathematicians or philosophers) believe that anything is real for any reason except that it is a conception of a true law or of a true theory? Have we any reason to assert that molecules are real except that the molecular theory is true—true in the sense of predicting rightly and interpreting its predictions in terms of acceptable ideas? What reason have we ever had for saying that thunder and lightning really happen at the same time, except that the conception of simultaneity which is such that this statement is true makes it possible to measure time-intervals? When these questions are answered it will be time to discuss whether relativity tells us anything about real time and real space.

The Relation between Geometry and Einstein's Theory of Gravitation.

By DOROTHY WRINCH and DR. HAROLD JEFFREYS.

THE term "geometry" has been used ever since the time of Euclid to denote two completely distinct subjects; but the formal similarity of their propositions has been so close as to obscure until recently the entire dissimilarity of their status in scientific knowledge. The Greek geometers seem to have been inspired originally by the need for a satisfactory method of surveying; at the same time, their logical turn of mind led them to present their results in the now familiar form of a deductive science. The characteristics of such a science are that a certain number of primitive propositions p_1, now called postulates, are stated at the beginning, and that from these, by a process of pure logic, further propositions q_1 are one by one developed. But this development is quite a separate process from that of deciding whether the primitive propositions are true or not, and if this is not done it is impossible to assert that the deduced propositions are true.

Different sets of primitive propositions p_2, p_3, . . . would give different sets of deduced propositions q_2, q_3, . . . and the complete working out of these is a science in itself; its results are all, therefore, of the form "p_1 implies q_1," "p_2 implies q_2," and so on. Euclid actually used in his development several postulates which he never explicitly stated, but which have been made explicit by modern writers; our present object, however, is not to indicate these, but to consider his geometry in the perfectly deductive form it would have had if he had actually stated them. We have noticed that in any other system in which any one of Euclid's postulates is false, many of his deduced propositions are also false. This, however, does not affect his method in the least; all his arguments are independent of the truth of the postulates, and in every case it is possible to assert—and this is all the modern geometer asserts—that *if* the postulates are true the propositions are true. A system like Euclid's is, therefore, a part of pure logic; the large division of pure logic that includes it as a very special case is pure geometry. Of the many systems of pure geometry now known, all are on just the same footing, and there is no sense in which any one of them is preferable to any other.

Euclid's contemporaries, however, were not interested merely in his logical method; they wished to identify the furrows in their fields with his lines, and the fields themselves with his surfaces; and to have some justification for this it was necessary to assume that his postulates were true of them. Only one example is needed to show how formidable an assumption this was. In order to prove one of his earliest propositions, Euclid assumes that a triangle can be picked up, transported bodily, and deposited on top of another. Imagine this process carried out when the triangles are fields! The impossibility of carrying it out implies that a most important proposition was not proved for the very case to which they contemplated applying his geometry, and hence that, so far as the knowledge of that day went, there was not the slightest reason for believing that geometry was applicable for its original purpose of earth-measurement. Yet its results, in so far as they were capable of being applied in actual surveying, seem to have been instantly accepted. Why? It may have been due partly to lack of disposition to criticise something that the critics felt they could not have done better themselves, a mental attitude that may perhaps still occasionally exist; but the chief reason was probably that some of the deduced propositions were directly verifiable, such as the proposition that the equality of corresponding sides of triangles in pairs implies that of corresponding angles; also many propositions about areas, expressed in numerical form, could be verified with some accuracy. As a result of these successes the whole system was accepted. But this could not have been a demonstration of the truth of the system; however many times a congruence proposition is verified for particular pairs of triangles, it will never be possible to prove it true for the next pair without the further assumption of some *principle of empirical generalisation* that is not included among the postulates.

Thus the grounds on which Euclid's results have been generally adopted in practice are not those of logical deduction from postulates known to be true *a priori*, as was for centuries believed; they are largely based on empirical generalisation. Thus two sciences with different fundamental data, but with many formally similar propositions, have grown up: the original name of *Euclidean geometry* will here be retained for Euclid's own development, while the experimental science of measurement will be called *mensuration*. The latter was not developed on its own account, the reason being probably that it is a physical science, and that so long as a theory gives results in accordance with observation, physicists in general show little disposition to investigate the security of its foundations.

All experimental science depends on some postulate or postulates that imply that empirical generalisation is justifiable: no amount of experiment will enable us to make any inference unless we have some principle that enables us to generalise the results. Theories involving such a principle may be called *extensive*, while those not involving one may be called *intensive*. The latter include the whole of logic. Now no process of generalisation is used in pure geometry; every proposition is proved immediately and with complete certainty for every instance of its terms. Thus all pure geometry, Euclidean or otherwise, is intensive, while all physical sciences, including mensuration, are extensive. Thus, in the first great subdivision of scientific knowledge, geometry and mensuration fall on opposite sides, and nothing but confusion can arise from any attempt to treat them as identical. In geometry postulates are made about *any* point, or *any* line; in mensuration these are necessarily unverifiable, for they would have to be tested for every possible instance before they could be treated as postulates. They can thus be obtained only by generalisation from results that *are* obtained by experiment, and therefore cannot possibly be primitive propositions.

It may be remarked in passing that generalisation was condemned by traditional logic. The fact that scientific men have not studied its validity for themselves is the chief reason for the present chaotic condition of the theory of scientific knowledge. This important and basic principle appears to involve necessarily the notions of *probability* and *combination of observations*; yet in works purporting to be theories of scientific knowledge these topics are habitually ignored altogether or else relegated to the last chapter. Much credit is due to Dr. N. R. Campbell for placing the theory of probability in its proper position in his recent "Elements of Physics." The value of his treatment is injured by the adoption of the Venn definition of probability, which is logically unsound and scientifically inapplicable; but to accord probability its true status in scientific knowledge is the first great advance in the theory.

This neglect of mensuration, while geometry was making rapid progress, has led physicists to give undue attention to the latter subject and an undue physical status to its concepts, especially to that of *space*. Metrical geometry has come to be regarded as the theory of the measurement of space; but space has no status among the subject-matter of mensuration. A physical measurement of length is always of the form: "When the zero mark on the (so-called rigid and straight) scale is in contact with the particle A, and the edge of the scale is in contact with the particle B, B lies between the nth and $(n+1)$th divisions of the scale." This involves no reference to space. Even the notion of rigidity, which is often regarded as spatial, is not so in practice. It is an experimental fact that many bodies exist which under ordinary treatment have the property that, if the distance between two points of the one can be made to include the distance between two points of the other, in some configuration, then, however the bodies are displaced, this remains true; and our rigid scales are such bodies. This, with the purely mechanical process of scale dividing, is all that is needed to make measurement possible. In actual physical calculation, again, we simply use the measures themselves without any reference to "space"; and the final result can be stated wholly in terms of such measures. If the notion of space is introduced at any stage of the investigation, it necessarily eliminates itself before the close. There are, of course, many so-called measurements of length in physics, such as the diameter of the earth and the distance of the sun, which cannot be made by means of rigid scales; these are not, in the strict sense, measured at all, but inferred from measures of certain angles by means of physical laws obtained from other experiments. Time, as actually used in physics, is on a similar footing to distance measures, and not to space.

The relations between the measured positions of bodies at different times form the subject of dynamics, which reduces to mensuration in a special case. It is an extensive science, and therefore epistemologically quite different from any four-dimensional geometry, which must from its nature be intensive. For this reason we consider that the theory of gravitation must be treated on extensive lines, and disagree with Prof. Eddington's presentation of Einstein's theory as a section of geometry. The principle of the irrelevance of the mesh-system, in particular, does not seem to be presented in its true light in his

"Space, Time, and Gravitation." This principle states that there are relations between the coefficients in the formula for ds^2 which hold, no matter what system of co-ordinates is chosen. Eddington regards the co-ordinate system as decided upon arbitrarily, having no real physical importance, and always eliminating itself in any actual physical process, while the only thing that has physical importance is space-time, which he treats on purely geometrical lines. From this point of view the principle is evidently correct; but it is not the point of view of physics. In physics the co-ordinate systems actually chosen are adopted entirely because they give specially simple forms to relations between measured quantities, and thus are not chosen arbitrarily. It would therefore be conceivable, and indeed not improbable, that there could be no relations between the g's that would not have special forms with ordinary co-ordinate systems. On the other hand, the properties of space-time never appear in physical laws; thus it is space-time that eliminates itself when the problems are reduced to terms of measurement, and the irrelevance of the mesh-system is a proposition, not about the unimportance of convention, but about physical measurements themselves. Hence it is a part, not of geometry, but of dynamics, and can be arrived at only by extension. Now that the predictions of the theory have been verified, the proper course to adopt is to derive the form of ds^2 from the experimental results that these express, and to regard the principle as an interesting experimental result.

Einstein's own presentation differs somewhat from Eddington's, but is also open to some objections. In his "Relativity, the Special and the General Theory" (English translation) Einstein states on p. 2 that he uses the term "geometry" in its usual sense of the logical connection of ideas (? propositions) among themselves. Then, on p. 3, he introduces the further proposition that two points on a practically rigid body always correspond to the same distance, however the body may be displaced, and considers that this converts geometry into a branch of physics. This is not the case; it can only give series of implications between propositions of the truth of which we are ignorant, until some of these propositions have been proved by sensory experience, which is not a part of geometry; they also require a process of generalisation to yield results of sufficient generality to form the basis of a geometry, so that a science reached in this way must be extensive.

On p. 9 of his book, Einstein's attitude towards "space" is closer to ours than to Eddington's, for he resolves to shun the word entirely, admitting that he cannot form the slightest conception of its meaning, and replaces it by the notion of position (*i.e.* measured position) relative to a practically rigid body of reference. In the latter part of the book he appears to regard space, not as a primary entity of Nature, but merely as a conventional construct, composed of the aggregate of all possible values of the three position co-ordinates. In this form the notion may be useful in theoretical work, but we cannot attribute any ultimate physical importance to a thing we have constructed ourselves. In fact, he makes it clear on p. 60 that the principle of relativity is a postulate to be tested by experience: a suggestion offered as possibly true, but with no *a priori* necessity about it. Its validity, in the opinion of its author, rests wholly on the success of its physical predictions. Consequently, as was stated above, the correct procedure now is to deduce the theory from the facts originally predicted by it, with whatever further postulates may be necessary.

Although we have criticised the chief current expositions of the Einstein theory, it is the omission of physicists to provide any satisfactory analysis of the foundations of their own subject that is chiefly at fault, and the remedy is a proper discussion of the relation of physical laws to the observations on which they are founded, and of the probability of inferences based upon them.

We may devote some attention to the question of the comparison of standards at different places, which must play an important part in any theory of measurement. Before the publication of the special theory of relativity, the accepted view was comparatively simple: the measured length of the conventional rigid bar was supposed to be the same however it was displaced and turned, and the same applied to the period of vibration of a clock or an atom (in the former case subject to the known influence of temperature and gravity). This gave a convenient basis for comparison of standards, for all could be expressed in terms of some standard instruments. The special theory, however, showed that this statement is not merely inconvenient as a working rule, but also demonstrably false, for a bar must have different measured lengths according as it is moving relative to the observer along or across the direction of its length. The possibility of a comparison was restored by Einstein's system of light signals; time and length standards were supposed unaltered by displacement, provided the observer was moving with them. But whether he was moving with them or not, a certain interval $\int ds$, measured between consecutive vibrations of the clock or between points on the bar, remained unaltered. Also the condition that $\int ds$ was stationary for small variations in the path was found to give the conditions satisfied by a particle moving at a great distance from matter.

Thus this differential element ds had a dual importance in the special relativity theory. In the general theory this is generalised, but it may be noticed that it is just possible that the two *rôles* may really be separated in a gravitational field. The consequences of this would be peculiar. It is well known that the assumption that ds, taken through a period of vibration of an atom, is independent of position, leads to the prediction of a shift of solar spectral lines; though this is so mixed up with shifts arising from other causes that it is impossible to say definitely whether it has been observed or not. But it is not so well known that the assumption that would lead to no spectral shift leads to the result that the wavelength on emission of light from a particular type of atom is a function of position; thus the abandonment of *ds* as the fundamental measured quantity would not make it possible to carry both length and time standards about unaltered. Probably the difficulties arising from the hypothesis that *ds* does not play two parts are so great as to render it quite unplausible.

The Metaphysical Aspects of Relativity.

By PROF. H. WILDON CARR.

THERE is a possible misconception in the application of the term "metaphysical" to the new principle of relativity which it is advisable to clear up. In the great era of the triumphant advance of the positive sciences, which began about the end of the first third of the nineteenth century, metaphysics was decried as the main obstacle to scientific progress. Following the lead of Auguste Comte, the workers in the sciences held it up to scorn as obscurantism. The derision and reproach which were then poured on it have clung to it ever since. There are many to-day who acknowledge, indeed, that metaphysics must be assigned a place in the hierarchy of the sciences, but interpret the Aristotelian definition, "that which follows or comes after physics," as indicating a dark realm of the yet unknown, or even of the unknowable, which surrounds the clear zone of positive knowledge, into which we may peer, but will discern nothing. The objects of metaphysics—the soul, the cosmos, the deity—are in this view vain imaginings, not objects of which there can be knowledge in the scientific meaning—that is, objects amenable to the experimental method. Such a view simply ignores the scientific tradition. Modern science is the result of the formulation and adoption of the experimental method, but the experimental method is not self-evident or inherently rational; it depends on a metaphysical concept, and its rationality can be established only by metaphysical principles. To contrast, then, the experimental method with the principles on which it depends, to describe one as the realm of science and the other as the realm of ignorance or unknowability, is from any philosophic point of view stultifying, and, in the literal sense, absurd.

What has made it possible to consider metaphysics as an unreal science, or as a realm of unreal fancy, is the peculiar position in regard to the natural sciences in which the purely mathematical sciences stand. Mathematics does not use the experimental method, and in the hierarchy of the sciences mathematics seems sufficient of itself for the foundation and support of the whole superstructure. But mathematics is only an abstract science of quantity; its concepts lack the one essential character which experimental science calls for—concreteness—and this metaphysics alone can supply.

The modern era of philosophy from Descartes onwards has been dominated by the insistence of the scientific problem—that is, the problem of the ultimate nature of the reality we study in physical science by the experimental method. This interest in the nature of scientific reality replaces the main interest of the philosophy of the mediæval period, which was concerned with the origin and destiny of the human soul, and, more generally, with the relation of man to God. If modern philosophy may be said to join hands with the ancient philosophy of Greece, it is not in the identity of its interest; for, though the Greeks were mathematicians, they had no conception of the experimental method as we practise it, and it is even doubtful if it could have been made to appeal to them on the ground of rationality.

The principle of relativity is the direct outcome of the application of the experimental method, and the full force of its appeal is based on our absolute confidence in the metaphysical concept of reality which is the ground and reason of that method. The experimental method has taken possession of the modern mind, and it assumes for us something like the unmodifiable character of an instinct. If experiment proves a certain velocity to be constant under conditions which require us to predict its variation; if experiment shows the movement of a source of light to be without the expected effect on the velocity of propagation—well, it is our concept of the nature of reality which must adapt itself to the experiment. The prediction is based on the concept that space and time provide an absolute system of reference; the null result of the experiment negatives that concept, and henceforth space and time are "shadows"; they must vary, because under varying conditions velocity is constant.

Those who affirm that the principle of relativity is purely mathematical, and not metaphysical, and, therefore, resent the intrusion of metaphysics into the discussion of its equations, conceive the principle to be purely methodological, to be concerned only with abstract quantitative measurement, and merely to substitute a very complex and difficult set of equation-formulæ for a discarded simpler one, in the interest of greater precision and accuracy alone. Those who take this view seem to me to misapprehend the significance of the principle. It is to be understood only when taken in its historical connection with the metaphysical constructions of the great philosophers.

Since Descartes, the speculations of philosophy have centred round the concepts of substance and cause, and the principle of relativity in its two phases, special relativity (the restricted theory) and general relativity, is essentially concerned with these two concepts. The first phase, in its negativity towards the æther hypothesis, is a reform of the notion of substance; and the second, in its rejection of influence and its substitution of equivalence for attraction in a new theory of gravitation, is a reform of the notion of cause.

Two opposing principles in regard to both these concepts—substance and cause—have been struggling to establish themselves throughout the modern period—one taking as its type the objective or passive aspect presented by the world to the mind of the observer, the other taking as its type the subjective activity of the mind itself in perceiving, imagining, understanding, willing, and acting. The first type we have in Descartes' concept of material substance as consisting in extension alone, and in his concept of cause as the mechanical action and interaction of a definite quantity of movement imparted to the extended substance—the concept of a mechanism which embraces the whole universe, organised and unorganised, exclusive only of the other substance, thought or thinking, present in human beings alone. Later we have the same type in the more familiar concepts of Newton—absolute time and absolute space. "Absolute time, in itself, and from its own nature, flows equally, without relation to anything external." "Absolute space, in its own nature, without relation to anything external, remains always similar and unmovable." The other type of concept we have in Leibniz's monadology. Substance is not passive, but active; cause is not movement, but force. What does nothing is nothing. Time and space are *ordines rerum non res*. Things are centres of active force.

It is with these concepts of substance and cause that the principle of relativity is primarily and mainly concerned, and these concepts are metaphysical constructions. Experimental facts have called for the formulation of the principle, but those facts themselves have slight importance in the practical sphere; it is their theoretical consequences which are far-reaching and revolutionary. They are facts which prove to be decisive in regard to metaphysical problems. The experiments are concerned with such infinitesimals as forty-two seconds in relation to a century, or a variability of 2¾ in. in the diameter of the earth. It is not the facts themselves, therefore, that are important, but their significance. According to the view which I have put forward in my book, "The General Principle of Relativity in its Philosophical and Historical Aspect" (Macmillan and Co.), the principle of relativity definitely decides for us that our universe is monadic, and that our science does not derive its validity from a reality independent of the monads, but from a power inherent in the monads to co-ordinate ever-varying points of view. By monads I mean minds, but minds conceived as metaphysical reals.

The point of supreme and central importance in the principle of relativity in its bearing on metaphysics is its negative attitude to the concept of absolute space and absolute time continua. The principle accepts the null result of the experiments as decisive in regard to the non-reality in the physical sense of such continua, and it refuses to recognise any necessity to construct *ad hoc* a hypothetical absolute space-time system. On the other hand, it claims to provide a formula which expresses the identity of an event for two observers in different systems who pronounce it to be one and the same, without the necessity of affirming an absolute order independent of their systems of reference.

Why does this seem paradoxical and in contradiction to our ordinary experience? Because our experience consists in the observation of events which we do not cause; which we refer to in our intercourse with our fellows as common to them and to us; and to which throughout life we, automatically or consciously, react. We argue by what appears to us the most perfectly natural reasoning that the identity of an event for two different observers implies an absolute order by reference to which alone differences of observation can be reconciled. This absolute order, we think, can be nothing else but the determination of every event in regard to every other event in an absolute coexistence in space and in an absolute succession in time. We conceive, therefore, an absolute space-time order, and suppose our private space-time systems are related to it. Such is the course of reasoning which appears natural, and such is the logical necessity from which it appears impossible to escape. Metaphysicians have long disputed it, but their arguments have been generally set aside as logomachies. Experiment has now falsified it.

What sort of thing, then, is the relativist universe? Substance and cause—that is, the principle of unity and the principle of uniformity—are definitely transferred from the object to the subject of experience. I do not mean that object and subject are dissociated; I mean that substance and cause are declared to be functions of the essential activity, and not of the passivity of experience. Thus the universe depends on the subject of experience, not, indeed, in the old and often derided sense in which the philosopher is caricatured as evolving an external world out of his own inner consciousness, as the spider spins its web, but in the sense that the universe is the co-ordination which the observer effects. The universe has four dimensions—the three dimensions of space, and the one dimension of time. The principle of co-ordination is that every observer uses his own axes of dimension, taking his system of reference as fixed in relation to all systems which for him are moving, and he is able to do so because his four axes are variable, and every change in his own system of reference, relatively to other systems, is compensated by a variation in his axes of co-ordination which preserves the ratio constant.

The universe, then, which the principle of relativity affirms is a universe in which there is no absolute space-time order; in which every event is exhausted in the contradictory descriptions of observers in different systems of reference; in which systems of reference are ultimate without being absolute, and relative without being externally conditioned; in which every system is self-sufficing and contains its own norm, a norm which remains constant by changing as the system changes. In such a universe, are mathematics and physical science possible? The relativist claims that they are capable of infinitely greater precision and consistency than they could ever attain while obstructed by the old concept.

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A BIBLIOGRAPHY of all books, pamphlets, papers, articles, and other publications on the subject of relativity has been prepared by Dr. H. Forster Morley, director of the International Catalogue of Scientific Literature. The list includes nearly 650 titles, arranged in chronological order from 1886 to the end of last year. It would occupy about thirty columns of NATURE, and, much as we should like to print it in full, limitations of space render this impossible. We have, therefore, extracted from Dr. Morley's bibliography the titles of published books and pamphlets upon relativity and related subjects, and also the references to articles, notes, or other contributions which have appeared in the pages of NATURE. The complete bibliography is so valuable that we trust it will be published in full either by a scientific society or in a leading work on relativity. Dr. R. W. Lawson has kindly added the titles of a number of German works.

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Notes.

The new session of Parliament was opened by the King in person on Tuesday. Reference was made in the King's Speech to a measure to be introduced into the House of Commons "to deal with the safeguarding of essential key industries of the country, and with certain aspects of unfair and abnormal industrial competition."

A meeting of the organising committees of all the Sections of the British Association will be held at Burlington House on Friday, February 25, to consider possible arrangements for joint programmes and related matters for the Edinburgh meeting of the Association in September next. Dr. Ethel Thomas, recorder of Section K (Botany), asks us to say that she would be glad to hear as soon as possible before February 25 from those who propose to offer papers for the Edinburgh meeting, and no doubt the recorders of other Sections would like to receive similar early notice.

Support for the appeal for the protection of the optical glass industry which appeared as a leading article in Nature of February 10 comes in the form of a series of resolutions passed by the Optical Society at its general meeting on the same date. The importance of optical munitions is emphasised, and it is pointed out that such supplies can be maintained only if the necessary materials, manufacturing establishments, and skilled labour are available. No other industry can by adaptation of existing resources produce the class of work required. The supply of optical glass required by this country should also be ensured. Another point made is that although the world's pre-war demand for optical glass was only about 25 tons per annum, some sixty different varieties are required; experience has shown that manufacture under these conditions cannot be a commercial proposition. In conclusion, it is urged that, in the interest of research, no obstacle should be allowed to prevent men of science from obtaining the instruments necessary for their work. The society is convinced that the optical industries of this country must be preserved and developed, and the President of the Board of Trade is to be asked to receive a deputation to explain more fully the position of these industries.

The gold medal of the Royal Astronomical Society was presented on February 11 to Prof. H. N. Russell for his work on the theory of star-development. The retiring president, Prof. A. Fowler, recalled in his address that Prof. Russell had introduced them in that very room to the giant and dwarf theory nearly eight years ago. Although a theory on the same lines (the division of the stars into two groups in which the temperature is rising and falling respectively) had been proposed many years earlier by Sir Norman Lockyer, it ran so counter to the then accepted views that he (Prof. Fowler) acknowledged that he had remained unconverted for some time; but recently several lines of evidence have converged to support the truth of the theory, namely, (1) the accumulation of additional parallaxes, both visual and spectroscopic; (2) the theoretical researches of Prof. Eddington and others on the physics of giant stars and the correlation of temperature with mass; and (3) the recent optical confirmation of the immense bulk of the typical red giant star Betelgeux. There is now little dispute as to the main lines of the theory, though there is room for much further work, in which Prof. Russell is taking a prominent part, on the problem of the nebulæ and Wolf-Rayet stars and their place in the scheme of development. Prof. Russell, in returning thanks, expressed his indebtedness to Prof. E. C. Pickering for determining the spectral type of his parallax stars, and noted that Prof. Hertzsprung and himself had put forward the theory simultaneously.

In recent years M. l'Abbé Breuil has contributed to *L'Anthropologie* a series of memoirs on the rock-paintings of Spain. In the last of these (June, 1920) he sums up the general results to which his studies have led him, and states his belief that all known examples can be arranged in an evolutionary series dating from the closing phases of the Ice age to the dawn of the Neolithic period. In a lecture given at the Institut Français, Cromwell Gardens, S.W., on February 9, the Abbé exhibited a series of original slides illustrating the remarkable art which flourished in southern France and throughout the Spanish Peninsula during the age of the Reindeer, and summed up for his hearers the conclusions reached after many years of systematic investigation. He believed that in the region covered by the art of the cave-men three centres or localities of independent or semi-independent development could be distinguished, North Spain and South-West France forming one centre, East Spain a second, and South Spain a third. The paintings and engravings in the first and second of these cave-areas were, he believed, the work of different peoples; although both were hunters, both giving graphic and realistic representations of the animals they followed and captured, the mammoth, reindeer, bison, and horse. In South Spain, on the other hand, the influence of a pastoral people was to be observed on cave art; it is in this centre that the final degradation of the earlier realistic art of the north into the later linear, conventional form of the south could be detected. There seems reason to believe that it may be possible to trace the evolution of an alphabetical system from the original graphic art of the earlier cave-men. The cave art of South Spain has many points in common with the art of the Bushmen of South Africa.

Owing to the recent decision of the Government that, for the present, no new schemes which involve the expenditure of public money shall be proceeded with, the Ministry of Agriculture and Fisheries informs bee-keepers that no further progress can be made at present with the Bee Disease Bill which was introduced into the House of Lords on December 20 last. The Ministry has also been making preliminary arrangements for the establishment of a Bee Advisory Committee which, it was hoped, would represent thoroughly every section of the bee-keeping industry; its function would be to advise the Ministry on all apicultural matters, including the question of legislation respecting bee diseases. In view of the need for economy and for the postponement of legislation, it will be necessary to delay the formation of this Committee. In the meantime, it is hoped that bee-keepers will take steps to organise themselves in order to arrive at a means of expressing an agreed opinion on the measures to be taken for the protection and furtherance of the industry. Arrangements for the examination of diseased bees no longer exist at the Department of Comparative Anatomy, The Museum, Oxford. Pending the appointment by the Ministry of a bacteriologist to undertake such work, Dr. J. Rennie has kindly consented to carry out examinations and to furnish reports to the bee-keepers concerned. In future, therefore, specimens, together with the name and address of the sender, should be sent to Dr. J. Rennie, Marischal College, University of Aberdeen.

SIR ROBERT HORNE, President of the Board of Trade, in opening on February 10 the Efficiency Exhibition organised by the *Daily Mail* at Olympia, referred to the importance of science and research to industry. In the past we had been too much accustomed to develop business without regard for the sciences or arts; now that attitude is passing away, and the sciences, arts, and industry are working well together. As examples of the success which has attended the co-ordination of effort, Sir Robert mentioned the Dorman appliances for the transmission of wave-energy through water, and the progress which has been made in preserving the health of the nation. We are compelled to defer an account of some of the exhibits of scientific interest until next week, but wish now to direct particular attention to the stand organised by London University, on which Prof. Fleming has arranged a number of the original valves and lamps used by him when he was evolving the thermionic valve. The series enables a view to be obtained of the genesis of one of the most valuable of modern inventions, which was itself the outcome of purely scientific research.

SIR ERNEST SHACKLETON, the *Times* announces, is planning a two years' expedition to Arctic regions, and proposes to leave England in May or June next, accompanied by a dozen men chosen chiefly from those who accompanied him on former expeditions. He proposes to sail for Hudson's Bay, where 150 dogs will be embarked, and then to proceed, *via* Baffin's Bay, through Lancaster Sound to Axel Heiberg Land. The passage of Lancaster Sound and Barrow Strait and the course to be followed to the northward must depend largely on ice conditions. The main object of the expedition is said to be to explore the region between Axel Heiberg and the Parry Islands. Parts of this area were explored between 1898 and 1902 by Otto Sverdrup's expedition in the *Fram*, when surveys were made by G. Isachsen of the coasts of Axel Heiberg, Ellef Ringnes, and Amund Ringnes Lands. Stefansson, travelling from Prince Patrick Island, visited the region in 1915 and 1916, and discovered two new islands in the Gustav Adolf Sea and one in the Prince Gustav Sea, besides finding that Ellef Ringnes Land is in reality two islands. The American Crocker Land Expedition under Mr. D. B. Macmillan in 1916 reached King Christian Island, travelling south-westward from Ellesmere Land. A great deal of work, however, remains to be done, and there is little doubt that Sir Ernest Shackleton intends to push eastward into the unknown Beaufort Sea, where land possibly exists, although Peary's Crocker Land has been disproved and Stefansson has found a relatively narrow continental shelf. It is reported that Sir Ernest Shackleton has bought the Norwegian whaling vessel *Foca I.*, which will shortly leave Tromsö for England. For some years this vessel has been used in carrying stores and men to Spitsbergen for a Norwegian mining company.

SIR LYNDEN MACASSEY in his address on February 11 to the Institute of Industrial Administration upon present-day industrial psychology attributed our present industrial discontent (i) to the failure of Capital to give sufficient attention to the question of administration, and (ii) to the lack of economic information, both general and particular to their respective industries, among the workers. He pleaded for a re-valuation of the factors of production so as to reach a nobler conception of the responsibilities and possibilities of administration. It will be generally agreed that in the past far too much has been left to chance, and that the time has come when this side of our industrial life must be completely overhauled. There may, perhaps, be less general agreement with Sir Lynden's view that a second condition of securing efficiency in production is that Labour shall be regarded as entitled to "know the facts," obtained from an efficient costing system, about the industries in which it is engaged. Yet facts of this kind have infinitely greater weight than an unsupported statement of the management in which, unfortunately, the men have probably little or no faith. Sir Lynden is inclined to underestimate the extent to which welfare work is regarded with suspicion, and his suggestion for its extension will meet with considerable criticism from those who are demanding that they shall be allowed an increased share in all branches of management.

THOUGH the various British firms which are specialising in the manufacture of organic research chemicals continue to add from time to time to the range of products made, their lists are still far behind those issued by the German firms before the war in the variety and complexity of organic chemicals offered. The slow progress made is due to difficulties with which all chemists have become familiar since 1914, and not the least of these is the uncertainty of the Government policy towards the fine chemical industry as a whole. Meanwhile, research work must go on, and since the date of the Sankey judgment research chemists have again begun to make use of German sources of supply, which, it may be added, are no longer so abundant, cheap, and various as they were in 1914, though they appear to be rapidly improving. As it seemed possible that the Dyestuffs (Import

Regulation) Act, 1920, might interfere with the importation of such chemicals, the council of the Institute of Chemistry addressed a letter to the Board of Trade inquiring whether licences would be necessary for the import of small quantities of organic chemicals (including intermediate products used in the manufacture of dyes, etc.) required solely for research purposes. The Board of Trade in its reply states that whilst it is not possible to regard small quantities of organic intermediate products which may be required for research purposes as being outside the scope of the Act, the Board will be prepared to issue general licences for the importation of such products to approved research institutions, covering periods of three months and limited only as to total quantities. This procedure obviates the necessity of separate applications for a large number of small items, but it will be a condition of the issue of such a general licence that a detailed return shall be furnished, at the end of the three months during which the licence is in operation, of the quantities of each product actually imported under it. This ruling indicates that the authorities are prepared to interpret the Act in such a way as not to hamper the prosecution of research.

The Parkin prize, value 100*l.*, will be offered by the Royal College of Physicians of Edinburgh for the best essay "On the Effects of Volcanic Action in the Production of Epidemic Diseases in the Animal and in the Vegetable Creation, and in the Production of Hurricanes and Abnormal Atmospheric Vicissitudes." Essays intended for competition, which is open to competitors of all nationalities, must be written in English, and must reach the secretary not later than December 31, 1921. Each essay must bear a motto, and be accompanied by a sealed envelope bearing the same motto outside and the author's name inside.

The Department of Scientific and Industrial Research has approved the formation of a Research Association for the Cast Iron and Allied Industries as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. The secretary of the committee engaged in the establishment of this association is Mr. Thomas Vickers, 174 Corporation Street, Birmingham.

We learn from the *British Medical Journal* of February 12 that an institute of biology named after Ramon y Cajal has been established at Madrid. It consists of four sections, devoted to human and comparative histology, neurology, physiology, and experimental pathology respectively.

Our Astronomical Column.

Ionisation in the Sun.—Two papers by Dr. Megh Nad Saha have recently appeared in the *Phil. Mag.* (vol. xl., pp. 472, 809), in which the author suggests an explanation of the varying character of the spectra exhibited by different elements in the sun. It is well known that some elements are represented by both enhanced and arc lines. Others show enhanced lines only, while a few have not been found at all. Prof. Fowler has ascribed these variations very largely to the different atomic weights of the elements concerned, but Dr. Saha is of the opinion that atomic weight is only of minor importance, being largely balanced by selective radiation pressure, and regards the variations mentioned above as arising from the different responses of elements to the stimulus existing in the sun. The enhanced lines are assumed to be due to radiations from "ionised atoms" (*i.e.* atoms that have lost an electron) rather than to a mere increase in temperature, and the different ionisation potentials of the elements will thus cause their varying behaviour. Calculations are given of the percentage ionisation of various elements at different temperatures and pressures. The results certainly agree quite well with the observed differences of behaviour of the elements chosen, and also with their individual variations in different regions of the sun.

The First Voyage Round the World.—Prof. Pio Emanuelli, of the Vatican Observatory, contributes an article to the *Corriere d'Italia* of December 20 last on the voyage of Magellan four hundred years ago. Magellan sailed from Spain on September 20, 1519, with five ships. He stayed in Brazil for some months, during which, as his biographer Pigafetta tells us, the potato was tasted for the first time by Europeans.

On the resumption of the voyage to the south the Straits of Magellan were discovered and traversed, the ships reaching the Pacific on November 28, 1520. On April 27, 1521, Magellan and several of his companions were treacherously slain in the Island of Zebu, in the Philippines. Some of the ships were captured, while others had to be abandoned owing to insufficient crews. Only one ship, the *Victoria*, returned to Spain, arriving on September 6, 1522, with the 18 survivors of the expedition, which had originally numbered 237.

Prof. Emanuelli notes that the first clear and definite description of the Magellanic clouds dates from this expedition. Thus they deservedly perpetuate Magellan's name in the heavens. Attention is also directed to the fact that until this voyage the geography of the earth as a whole was less well known than that of the planet Mars at the present day.

Secular Change in the Period of δ Cephei.—Prof. Eddington, in studying the pulsation theory of the Cepheids, indicated that a fairly rapid secular change of period was to be expected, and referred to Hertzsprung's conclusion that the period of δ Cephei was diminishing by 0·079s. per annum. Mr. H. Ludendorff gives a further discussion of the early observations in *Ast. Nach.*, No. 5076. He has carefully re-reduced the original observations of Mr. F. M. Schwerd, made between 1823 and 1826, and finds that they accord closely with the change of period announced by Hertzsprung. The formula of the latter gives a shift of the time of maximum amounting to −0·0121 of a period in 1825, while Schwerd's observations give −0·0134±0·005. The following values of the shift as given from other early series of observations are deduced:—Goodricke, 1785: shift −0·036×period ±0·005; Pigott, 1785: shift −0·035×period ±0·011; Westphal, 1818: shift −0·010×period ±0·008. Mr. Ludendorff considers that the reality of the change is placed beyond doubt by this discussion.

University and Educational Intelligence.

CAMBRIDGE.—As was generally expected, Report B in favour of the foundation of a separate women's university at Cambridge was rejected last week. Three of the six signatories, who produced the scheme after six months' labour, had signed its death-warrant by issuing a fly-sheet against it. The new scheme—C it may well be called—is supported now by a group of fifty-two. It offers women students degrees, teaching by the University for a limited number, also certain undefined privileges, but no power and no votes in the Senate or any controlling body of the University. Even this scheme seems to open up too many and too serious risks to the more conservative members of the University, who are appealing for support for a fourth scheme D. While rigidly limiting the number of women students admitted to the University and ensuring that they shall pay proper fees for teaching and examinations, this scheme limits any advance from the present position to the granting by diploma of titular degrees. Already several defections have taken place from the moderate party to the extreme conservative wing.

What might have been an agreed solution in 1897 can scarcely be accepted in that light in 1921, and unless the moderates, having shed their right wing, are prepared to go further than their fly-sheet suggests, it seems probable that the intervention of some outside body—the Royal Commission at present sitting on the financial resources of the University—will be sought.

THE annual prize distribution at the Sir John Cass Technical Institute was held on Thursday, February 10, when the prizes were distributed by Sir Frederick Black, who afterwards delivered an address on "Liquid Fuel in Peace and War." A summary of the work of the institute during the past session shows that the total number of students was 1060—a higher figure than in any previous year, and an increase of more than 50 per cent. on the previous session. An important development contemplated was the initiation of courses of instruction on petroleum technology adapted to the needs of those already engaged in the industry. In the course of his address Sir Frederick Black said that whilst the United Kingdom had become an important consuming centre of petroleum products, it was at present only on a comparatively small scale that petroleum was produced in this country. So far as manufacture or refining was concerned, much more work of that nature was likely to be undertaken at home, for large British companies interested in oil had their headquarters and distributing agencies here. After briefly describing how the products of petroleum used for fuel were obtained, Sir Frederick gave a general description of their use in internal-combustion engines and for steam raising. The war has developed enormously their use and established their importance. The relative advantages of oil and coal for marine purposes were discussed, special reference being made to the progress in the building of motor-driven ships since 1912. Great attention was being given to such important matters as the elimination of waste on the oilfields and in the use of liquid fuels. Oils that admitted of complete refining into such products as motor spirit and lighting and lubricating oils should be so dealt with in preference to burning the more valuable fractions for steam raising, provided that a heavier oil not capable of such complete refining could be made available.

Calendar of Scientific Pioneers.

February 17, 1600. Giordano Bruno died.—An enthusiastic supporter of the views of Copernicus and of other new learning, Bruno, after several years spent in visiting France, England, and Germany, returned to his native country, was arrested, and, refusing to recant his philosophical and scientific heresies, was burnt at the stake in the Campo di Fiori, Rome.

February 17, 1867. Alexander Dallas Bache died.—One of the most influential of American men of science, Bache was director of the United States Coast Survey. He played a leading part in the founding of the National Academy of Sciences.

February 17, 1874. Lambert Adolphe Jacques Quetelet died.—The designer and first director of the Brussels Observatory, Quetelet was also a statistician and applied the theory of probabilities to the physical and intellectual qualities of man.

February 17, 1875. Friedrich Wilhelm August Argelander died.—Trained under Bessel, Argelander in 1837 became professor of astronomy at Bonn, where he compiled his great catalogue and atlas containing 324,000 stars visible in the northern hemisphere.

February 18, 1899. Marius Sophie Lie died.
February 19, 1897. Karl Theodor Wilhelm Weierstrass died.—Both Lie and Weierstrass were among the most prominent workers in pure mathematics of last century. The former, though a Norwegian, for some years held a chair of mathematics at Leipzig, while Weierstrass was long connected with Berlin University. Lie's chief work was on the theory of transformation groups; Weierstrass's on elliptic functions and the theory of functions.

February 20, 1762. Johann Tobias Mayer died.—Director of Göttingen Observatory, Mayer left behind him valuable lunar tables which greatly aided in solving the problem of finding the longitude at sea.

February 20, 1907. Henri Moissan died.—Moissan in 1886 was the first to isolate fluorine. He improved the electric furnace, and by suddenly cooling a solution of carbon in molten iron produced small artificial diamonds.

February 22, 1875. Sir Charles Lyell died.—Lyell was the greatest master of English geology, and the publication of his "Principles of Geology" marked an epoch in the history of that science. This work was "an attempt to explain the former changes of the earth's surface by reference to causes now in operation." Lyell is buried in Westminster Abbey.

February 22, 1901. George Francis FitzGerald died.—Erasmus Smith professor of natural philosophy at Trinity College, Dublin, FitzGerald is remembered for his knowledge and versatility, his brilliant conceptions, and his stimulating influence on his fellow-physicists.

February 23, 1812. Etienne Louis Malus died.—A French military engineer of distinction, Malus died at the age of thirty-six, having three years previously made his great discovery of the polarisation of light by reflection.

February 23, 1855. Karl Friedrich Gauss died.—Mathematics, astronomy, optics, and magnetism all engaged the attention of Gauss, who in 1807 became professor of mathematics and director of the observatory at Göttingen. His important investigation of terrestrial magnetism belongs to the latter part of his life. With Weber he invented new instruments, set up an electric telegraph, and built the first magnetic observatory. The Gauss Tower on the Hohenhagen, near Dransfeld, was erected to his memory in 1911.

E. C. S.

Societies and Academies.

PARIS.

Academy of Sciences, January 24.—M. Georges Lemoine in the chair.—The president announced the death of M. Georges Humbert, member of the Academy.—P. **Termier** and L. **Joleaud**: The age of the phenomena of transport in the mountains of Gigondas (Vaucluse).—G. **Gouy**: A theorem of geometrical optics and its application to systems of prisms.—M. Pierre Bazy was elected a member of the section of medicine and surgery in succession to M. Guyon.—J. **Andrade**: The transverse elastic displacements of the centre of gravity of a cylindrical spiral and its doublets.—C. **Féry**: A mechanical clock with free escapement.—A. **Liénard**: The electromagnetic energy and thermodynamic potential of a system of currents.—G. **Reboul**: A new property of bodies poor conductors of electricity. An attempt to discover the causes of phenomena described in an earlier communication.—M. **Collignon**: The propagation of the sound of guns to great distances. The annual periodicity. Confirmation of results given in a previous communication: the law of annual periodicity has been verified up to November 18, 1918.—L. **Forsén**: The systematic nomenclature and constitution of the derivatives of molybdic acid. Representing molybdic acid by the formula

$$H_6Mo_3O_{12}.(3H_2MoO_4),$$

the composition of the complex salts of molybdates can be satisfactorily represented.—E. **Rengade**: The isothermal concentration of a solution prepared starting with two salts with different ions. A study of the compositions of the solution and deposited salts produced by the isothermal evaporation at 25° C. of a solution of ammonium nitrate and sodium chloride.—Mlle. J. **Bonnefoy** and J. **Martinet**: 6-Methylisatin. Two new methods are given for the preparation of this compound, the first starting with metatoluidine and methyl mesoxalate, and the second with metatoluidine, carbon bisulphide, and hydrogen peroxide.—E. E. **Blaise**: Derivatives of 1:4-diketones and semicarbazide. The primary product of the reaction between the diketone and semicarbazide is a disemicarbazone; this is readily converted in formic acid solution into an *N*-ureo-pyrrol.—G. **Mignonac**: A new general method for the preparation of amines, starting with aldehydes or ketones. The aldehyde or ketone is dissolved in an alcoholic solution of ammonia, finely divided nickel added, and the mixture kept violently shaken, treated with hydrogen at atmospheric pressure. Examples of the application of the method are given.—P. **Glangeaud**: The mountains of Margeride: their porphyric eruptions, cycles of erosion, and glaciers.—J. **Savornin**: The distribution and direction of the phosphate basins in western Morocco. The deposits of Beni Meskine and Oulad Delim are rich, very extensive, and of great commercial importance. The other basins described are only of theoretical interest.—A. **Lumière**: The harmful action of dead leaves on germination. A study of the substances extracted from dead leaves by water showed the presence of reducing substances capable of preventing the germination of seeds. Numerous successive extractions were required before these substances were completely removed. From these observations it is supposed that after the fall of the leaves rain-water extracts these harmful substances during the winter, thus partially sterilising the soil and removing oxygen, and it is only after the lapse of a certain period of time that sufficient oxygen is present in the soil to permit the germination of seeds.—G. **Tanret**: The presence of quinic acid in the leaves of some conifers. The leaves of the cedar collected in July contain 5 gm. of quinic acid per kg. of dried leaves. Similar results were obtained with larch leaves, but the examination of other conifers gave no quinic acid.—A. **Magnan**: The action of the water on the body and head of diving birds.—C. **Dekhuyson**: The biological semi-permeability of the external walls of the Sipunculideæ. Experiments are described which show that the external walls of *Phascolosoma vulgare* and *Sipunculus nudus* are semi-permeable in so far as pure water, carbon dioxide, and oxygen pass through with much greater velocity than salts in solution.—P. **Goy**: The lower plants and the accessory factors of their growth. From studies of the growth under varying conditions of several species of yeasts, moulds, and bacilli, the conclusion is drawn that vitamines are not indispensable to the lower plants, but that their evolution is considerably influenced by the presence of an organic body which has been isolated in a pure crystallisable state from cultures of *Mucor mucedo*. This substance is not an amino-acid, and contains neither nitrogen nor phosphorus.—H. **Bierry** and F. **Rathery**: Diabetes and glycemia.

Books Received.

Klimatographie von Osterreich. VII.: Klimatographie der Bukowina. By Dr. V. Conrad. Pp. 42. VIII.: Klimatographie von Mähren und Schlesien. By H. Schindler. Pp. 125. IX.: Klimatographie von Oberösterreich. By P. T. Schwarz. Pp. 133. (Wien: Gerold & Co.)

Annuaire de l'Observatoire Royal de Belgique, 1922. Pp. vi+316. (Bruxelles.)

The Flowering Plants of South Africa. Edited by Dr. I. B. Pole Evans. Vol. i., No. 2, February. Plates 11–20. (London: L. Reeve and Co., Ltd.; Johannesburg and Cape Town: Speciality Press, Ltd.) Coloured, 15*s*.; plain, 10*s*.

The Theory of Relativity. By Prof. R. D. Carmichael. Second edition. Pp. 112. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 8*s*. 6*d*. net.

Air Ministry, Meteorological Office. International Meteorological Conference. Report of Proceedings of the Fourth International Conference of Directors of Meteorological Institutes and Observatories and of the International Meteorological Committee, Paris, 1919. (M.O. 239.) Pp. 84. (London: Meteorological Office.)

Report of the Secretary of the Smithsonian Institution for the Year ending June 30, 1920. (Publication 2586.) Pp. 110+i plate. (Washington: Government Printing Office.)

Department of the Interior. Bureau of Education. Bulletin No. 65, 1919: The Eyesight of School Children: Defective Vision as Related to School Environment, and Methods of Prevention and Correction. By J. H. Berkowitz. Pp. v+128+xvi plates. Bulletin No. 7, 1920: Requirements for the Bachelor's Degree. By W. C. John. Pp. v+313. Bulletin No. 29: The National Crisis in Education: An Appeal to the People. Edited by W. T. Bawden. Pp. 191. (Washington: Government Printing Office.)

Smithsonian Institution. Bureau of American Ethnology. Bulletin 67: Alsea Texts and Myths. By L. J. Frachtenberg. Pp. 304. (Washington: Government Printing Office.)

Truth about Venereal Disease. By Dr. Marie C. Stopes. Pp. vii+52. (London: G. P. Putnam's Sons.) 1*s*. 6*d*. net.

Ministry of Finance, Egypt. Note on the Programme and Policy of the Government with Regard to the Investigation and Development of the Petroleum Resources of Egypt. By E. M. Dowson. Pp. v+48. (Cairo: Government Press.) P.T. 10.

Transactions of the Royal Society of South Africa. Vol. ix., part 2, 1921. (Cape Town: The Society; London: W. Wesley and Son.) 18*s.* 6*d.*

Products of the Empire. By L. Clinton Cunningham. Pp. 299. (Oxford: Clarendon Press.) 5*s.* 6*d.* net.

Why do We Die? By T. Bodley Scott. Pp. 123. (London: T. Fisher Unwin, Ltd.) 6*s.* net.

Calendario della Basilica Pontificia del Santissimo Rosario in Valle di Pompei per l'Anno 1921. Pp. 224+63. (Valle di Pompei.)

Elements of the Mathematical Theory of Electricity and Magnetism. By Sir J. J. Thomson. Fifth edition. Pp. viii+410. (Cambridge: At the University Press.) 30*s.* net.

The Dynamical Theory of Gases. By Prof. J. H. Jeans. Third edition. Pp. vii+442. (Cambridge: At the University Press.) 30*s.* net.

The Scientific Papers of Bertram Hopkinson. Collected and arranged by Sir J. Alfred Ewing and Sir Joseph Larmor. Pp. xxvii+480+plates. (Cambridge: At the University Press.) 63*s.* net.

Handbuch der Anorganischen Chemie. Edited by Prof. R. Abegg and Dr. Fr. Auerbach. Vierter Band. Erste Abteilung. Zweite Halfte. Pp. xiii+1072. (Leipzig: S. Hirzel.) 140 marks.

Agriculture and Irrigation in Continental and Tropical Climates. By Kinsley D. Doyle. Pp. xv+268. (London: Constable and Co., Ltd.) 19*s.* net.

Instinct in Man: A Contribution to the Psychology of Education. By Dr. J. Drever. Second edition. Pp. x+293. (Cambridge: At the University Press.) 10*s.* 6*d.* net.

Proceedings of the Cambridge Philosophical Society. Vol. xx., part 2. (Michaelmas Term, 1920.) Pp. 219–83. (Cambridge.) 5*s.* net.

An Introduction to Bacterial Diseases of Plants. By Erwin F. Smith. Pp. xxx+688. (Philadelphia and London: W. B. Saunders Co.) 50*s.* net.

Principles and Methods of Industrial Education. By W. H. Dooley. Pp. xi+257. (London and Sydney: G. G. Harrap and Co., Ltd.) 6*s.* net.

Psyche's Lamp: A Revelation of Psychological Principles as Foundation of all Thought. By Robert Briffault. Pp. 240. (London: G. Allen and Unwin, Ltd.; New York: The Macmillan Co.) 12*s.* 6*d.* net.

Studies in French Forestry. By Theodore S. Woolsey, jun. Pp. xxvi+550. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 36*s.* net.

Ou en est l'Astronomie. By l'Abbé Th. Moreux. Pp. vi+295. (Paris: Gauthier-Villars et Cie.)

Annuaire pour l'An 1921 publié par le Bureau des Longitudes. Pp. viii+710+A42+B17+C69. (Paris: Gauthier-Villars et Cie.) 8 francs net.

Memoirs of the Connecticut Academy of Arts and Sciences. Vol. vii.: The Appendages, Anatomy, and Relationships of Trilobites. By Dr. Percy E. Raymond. Pp. 169+xi plates. (New Haven, Conn.: Yale University Press.) 6 dollars.

A Research on the Eucalypts, Especially in Regard to their Essential Oils. By Richard T. Baker and Henry G. Smith. Second edition. Pp. xv+471+plates. (Sydney: Technological Museum.)

Perspective: The Practice and Theory of Perspective as Applied to Pictures, with a Section dealing with its Application to Architecture. By Rex Vicat Cole. Pp. viii+17–279. (London: Seeley, Service and Co., Ltd.) 18*s.* net.

A Diplomat in Japan: The Inner History of the Critical Years of Japan when the Ports were Opened and the Monarchy Restored. By the Right Hon. Sir Ernest Satow. Pp. 427. (London: Seeley, Service and Co., Ltd.) 32*s.* net.

The Copernicus of Antiquity (Aristarchus of Samos). By Sir Thomas Heath. (Pioneers of Progress: Men of Science.) Pp. iii+59. (London: S.P.C.K.; New York: The Macmillan Co.) 2*s.* 6*d.* net.

Early Annals of Ornithology. By J. H. Gurney. Pp. viii+240. (London: H. F. and G. Witherby.) 12*s.* 6*d.* net.

Ministry of Finance, Egypt. Survey Department. Meteorological Report for the Year 1913. Pp. xiv+240+xii. (Cairo: Government Press.) P.T.30.

Imperial Mineral Resources Bureau. The Mineral Industry of the British Empire and Foreign Countries (War Period). Antimony (1913–19). Pp. 34. (London: H.M. Stationery Office.) 1*s.* net.

An Introduction to Technical Electricity. By S. G. Starling. Pp. xii+181. (London: Macmillan and Co., Ltd.) 3*s.* 6*d.*

A Book of Gardening for the Sub-Tropics. By Mary Stout and Madeline Agar. Pp. 200. (London: H. F. and G. Witherby.) 6*s.* net.

Bergens Museums Aarbok, 1918–19. I Hefte. Naturvidenskabelig Roekke. Pp. 76+37+86+vii plates. (Bergen.)

An Account of the Crustacea of Norway. By G. O. Sars. Vol. vii.: Copepoda. Supplement. Parts vii. and viii.: Harpacticoida (continued). Pp. 73–92+xlix–lxiv plates. (Bergen: Bergen Museum.)

Diary of Societies.

THURSDAY, FEBRUARY 17.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. A. Herdman: Oceanography (The Sea-Fisheries).

ROYAL SOCIETY, at 4.30.—Dr. C. Chree: A Comparison of Magnetic Declination Changes at British Observatories.—Prof. H. M. Macdonald: The Transmission of Electric Waves Around the Earth's Surface.—Prof. T. H. Havelock: The Stability of Fluid Motion.—Prof. W. H. Young: The Transformation of Integrals.—J. L. Haughton and Kathleen E. Bingham: The Constitution of the Alloys of Aluminium, Copper, and Zinc containing High Percentages of Zinc.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. Martin Flack: Respiratory Efficiency in Relation to Health and Disease (Milroy Lecture).

LINNEAN SOCIETY, at 5.—Prof. G. B. De Toni: A Contribution to the Teratology of the Genus Datura.—Capt. J. Ramsbottom and A. J. Wilmott: A Plant Collection from Macedonia.—Dr. G. C. Druce: Shetland *Plantago* and Other Plants from the Northern Isles.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—F. Handley Page: The Handley Page Wing.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—E. H. Clifford: A Scheme for Working the City Deep Mine at a Depth of 7000 ft.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Prof. E. Wilson: Magnetic Susceptibility of Low Order: I. Instrumentation.

INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates' Meeting) (at 28 Victoria Street), at 7.30.—E. L. Bass: Engine Lubrication.

CHEMICAL SOCIETY, at 8.—L. J. Hudleston and H. Bassett: Equilibria of Hydrofluosilicic Acid. Part I. Mixtures of Hydrofluosilicic and Hydrofluoric Acids.—R. G. Fargher and H. King: Additive Compounds of Antipyrylaminodiacetic Acid and its Salts with Neutral Salts.—H. Bassett and T. A. Simmons: The System, Picric Acid—Phenyl Acridine.—F. S. Kipping: Organic Derivatives of Silicon. Part XXIV. *dl*-Derivatives of Silicoethane.—F. W. Atack: The Structural Isomerism of Oximes. Part I. Criticism of the Hantzsch-Werner Hypothesis of the Geometrical

Isomerism of Carbon-Nitrogen Compounds.—F. W. Atack: The Structural Isomerism of Oximes. Part II. Constitution of Oximes.—F. S. Kipping: Organic Derivatives of Silicon. Part XXV. Saturated and Unsaturated Silicohydrocarbons, Si_4Ph_8.

RÖNTGEN SOCIETY (at University College), at 8.15.—N. E. Luboshez: Intensifying Screens and Secondary Radiation.

FRIDAY, FEBRUARY 18.

ASSOCIATION OF ECONOMIC BIOLOGISTS, Annual General Meeting (in Botanical Lecture Theatre, Imperial College of Science), at 2.30.—Sir David Prain: Some Relationships of Economic Biology.

GEOLOGICAL SOCIETY OF LONDON, at 3.—Anniversary Meeting.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.—Dr. A. R. Friel: Zinc Ionisation and Electrolysis in the Treatment of Chronic Otorrhœa.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—J. F. Dobson: The Function of the Kidneys in Enlargement of the Prostate Gland (Arris and Gale Lecture).

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Annual General Meeting.—F. M. Farmer: The Desirability of Standardisation in the Testing of Welds.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Section) (at King's College, Strand), at 6.30.—L. B. Atkinson: Presidential Address.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.1), at 8.15.—Lt.-Col. J. G. Kennedy: Pathology of Relapsing Fever.—Dr. A. M. Cole: Five Cases of Sarciolopsia Infection.—Dr. A. Connall: Examination of Chrysops for Filaria in West Africa.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—S. J. Solomon: Strategic Camouflage.

SATURDAY, FEBRUARY 19.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. Fowler: Spectroscopy (Regularity in Spectra).

MONDAY, FEBRUARY 21.

VICTORIA INSTITUTE (at Central Hall, Westminster), at 4.30.—Lt.-Col. F. A. Molony: Prophecy.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—J. H. Evans: The Azygos System of Veins in their Association with Surgical Affections (Arris and Gale Lecture).

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street), at 8.—Miss H. D. Oakeley and Others: Space, Time, and Deity.

ROYAL SOCIETY OF ARTS, at 8.—Dr. E. K. Rideal: Applications of Catalysis to Industrial Chemistry: Processes of Oxidation (Cantor Lecture).

CHEMICAL INDUSTRY CLUB (at 2 Whitehall Court), at 8.—Lt.-Col. W. Cullen: South Africa.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Dr. H. Rice: The Rio Negro Casiquiare Canal and Upper Orinoco.

MEDICAL SOCIETY OF LONDON (at 11 Chandos Street, W.1), at 9.—G. E. Gask: Surgery of the Lung and Pleura (Lettsomian Lecture).

TUESDAY, FEBRUARY 22.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. Keith: Darwin's Theory of Man's Origin, in the Light of Present Day Evidence.

ROYAL HORTICULTURAL SOCIETY, at 3.

ROYAL SOCIETY OF MEDICINE (Medicine Section) (at Guy's Hospital), at 4.—Dr. G. H. Hunt: An Experimental Oxygen Chamber.—Dr. G. Marshall: Apparatus for Induction of Artificial Pneumothorax.—Dr. G. H. Hunt and Dr. E. P. Poulton: Congenital Heart Disease with Analysis of the Arterial Blood.—Dr. C. P. Symonds: A Case of Charcot-Marie-Tooth Muscular Dystrophy with Pseudo-Hypertrophy.—Dr. G. H. Hunt: Cardiac Efficiency in Normal and Pathological Conditions.—J. M. H. Campbell: Factors in the Causation of Dyspnœa.—Dr. J. A. Ryle: The Diagnostic Value and the Limitations of the Fractional Test-meal.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. Martin Flack: Respiratory Efficiency in Relation to Health and Disease (Milroy Lecture).

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. P. Chalmers Mitchell: Report on the Additions to the Society's Menagerie during the Month of January, 1921.—Prof. Elliot Smith: Exhibition of Photographs of Live Examples of Tarsius.—A. Mallock: Colour-production in Relation to the Coloured Feathers of Birds.—E. Dukinfield Jones: Descriptions of New Moths from South-East Brazil.—Dr. J. Stephenson: Morphology, Classification, and Zoogeography of Indian Oligochæta.—Dr. N. S. Lucas: Report on Deaths in the Society's Gardens during the Year 1920.—Dr. R. Broom: The Structure of the Reptilian Tarsus.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—P. Allan: Port Improvements at Newcastle, N.S.W.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—D. Charles: Improvements in Flashlight.

ROYAL ANTHROPOLOGICAL INSTITUTE (at Royal Society), at 8.15.—Sir Alfred T. Davies: The Scheme of the Welsh Department of the Board of Education for the Collection of Rural Lore in Wales through the Schools. To be followed by a Discussion.

WEDNESDAY, FEBRUARY 23.

ROYAL SOCIETY OF ARTS, at 4.30.—Sir Daniel Hall: The Present Position of Research in Agriculture (Trueman Wood Lecture).

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. W. J. Sollas: *Saccammina Carteri*, Brady, and the Minute Structure of the Foraminiferal Test.—Dr. T. S. Wilson: Notes on the Views of the Late Prof. C. Lapworth with Regard to Spiral Movements in Rocks during Elevation or Depression.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—J. H. Barker: Machinery Applied to Mass Production.

THURSDAY, FEBRUARY 24.

MEDICO-PSYCHOLOGICAL ASSOCIATION OF GREAT BRITAIN AND IRELAND (at 11 Chandos Street, W.1), at 2.45.—Sir Frederick Mott and Dr. Hayao: The Pathology of Dementia Præcox, especially in Relation to the Condition of the Ovaries.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—F. Balfour Browne: Mason Bees and Wasps.

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Sir Ray Lankester: A Remarkable Flint-implement from Selsey Bill.—Dr. E. J. Allen: Regeneration and Reproduction of the Syllid Procerastea.—E. C. Grey and E. G. Young: The Enzymes of *B. coli communis*. Part II. (*a*) Anaerobic Growth followed by Anaerobic and Aerobic Fermentation. (*b*) The Effects of Aeration during the Fermentation.—Dr. A. E. Everest and A. J. Hall: Anthocyanins and Anthocyanidins.

ROYAL SOCIETY OF MEDICINE (Tropical Medicine Section), at 5.—Sir Leonard Rogers: Presidential Address.—Dr. J. G. Thomson and Dr. A. Robertson: The Value of Laboratory Reports in the Diagnosis of Suspected Dysentery, and their Interpretation by the Clinician.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. Martin Flack: Respiratory Efficiency in Relation to Health and Disease (Milroy Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Prof. E. Wilson: Magnetic Susceptibility of Low Order. II. Susceptibility Values.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—Discussion: The Use of Light as an Aid to Publicity.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.

FRIDAY, FEBRUARY 25.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 4.30.—Sir Humphry Rolleston and Others: Discussion on The Diagnosis and Treatment of Congenital Syphilis and its Effects.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—R. H. Humphry: A Note on the Hot-Wire Inclinometer.—Profs. E. Wilson and Herroun: The Magnetic Susceptibility of Certain Natural and Artificial Oxides.—J. Guild: The Refractometry of Prisms.—T. Smith: Tracing Rays through an Optical System.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.30.—Dr. R. M. F. Picken: The Epidemiology of Measles in a Rural and Residential Area.

SATURDAY, FEBRUARY 26.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. Fowler: Spectroscopy (Celestial Spectroscopy).

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THURSDAY, FEBRUARY 24, 1921.

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National Aspects of the Fine Chemical Industry.

IN a speech rarely equalled for its quality and delicately woven argument, Lord Moulton recently put into clear perspective the case for fostering the fine chemical industry in this country. All who during the war-years shared with him the terror of what the chemical industry enabled our enemies to do will accept his view as to the imperative need of treating this as a key industry and stabilising it on a thoroughly satisfactory and efficient foundation. However vaguely we may visualise the boundaries of key industries in general, no one has any doubt as to whether the fine chemical industry comes within them.

One aspect of the importance of this industry may be compared with that of the shipping industry, for just as our maritime supremacy depends upon the strength of our Navy, and hence upon the ability to man it with a race of seafaring men directed by able officers, so also does our future position depend upon our chemical ability, and hence upon the employment of skilled workers directed by trained chemists engaged in a successful organic chemical industry. The necessary conditions for training our seamen are inherited as a birthright, while those for training our chemical workers have to be created. Such workers as those employed in the manufacture of organic chemicals and optical lenses must be trained from early life, and they become proficient only after many years.

It is reported from many quarters that German interests are making a determined effort to destroy those fine chemical manufactures already set up in this country by selling the particular commodities concerned at prices well below the cost of production here, whilst charging exorbitant prices for those chemicals of which they retain the monopoly. Such efforts should be resisted at all costs. The object is to relegate to the scrap-heap the costly plant set up in this country, and to terrorise those who might otherwise be willing to risk capital in developments of a like nature. As a nation we must in the long run pay more if we succumb to this attack and again allow the German monopoly to be established. Not only will a great loss of capital be incurred, but we shall also ultimately pay very dearly for the products now being sold at such low prices, because in a few years' time the far-reaching influence of the war debt will bring about a rise of production costs in Germany. It is also to be presumed that the exchange will become in a measure equalised.

Research workers in this country naturally feel concerned lest the machinery which the Government will make use of to effect the desired protection may adversely influence their work by limiting the supply, or increasing the cost, of research chemicals. It is to be hoped that the terms of the Bill will be such as can be interpreted to give satisfactory safeguards in both these respects. It cannot be supposed that British chemical manufacturers will welcome any measure which seriously hinders research, of which they have recently learned to appreciate the value so well. The patriotic manner in which the manufacturers of fine chemicals responded to the call made upon them at the outbreak of hostilities, and the unselfish service which many of them gave throughout the war, may be taken, we hope, as indicating their attitude in this matter. However, on account of the cost of labour, it is self-evident that the prices of chemicals made in this country must for a time be somewhat higher than those ruling in Germany. German workers to-day are paid the equivalent of 5*d.* an hour, while similar workers in England receive 2*s.* an hour. It is therefore clearly impossible immediately to equalise the prices of chemicals, even should we completely counteract the German effort to destroy the industry.

It is interesting to follow the course which the prices of many of these organic chemicals have taken since 1914. As soon as the supply of German products in the hands of dealers was insufficient to meet the demand, prices rose preposterously high; but as the manufactures became established here they were brought back to a level very near to, though a little higher than, the pre-war figure. This adjustment took place before the resumption of German competition. It may be assumed that the same factors will operate to reduce the cost of any new manufactures which are undertaken, if only we can patiently put up with the difficulties during the present years of transition.

Owing to the rate of exchange, it is possible for the moment to purchase research chemicals from Germany at very low prices. It is timely to remind those who have been ready at once to resume purchasing organic chemicals from Germany of the already successful efforts to supply research chemicals which have been made in this country at the instigation of the Association of British Chemical Manufacturers. Although it has been clearly impossible since the war to prepare a complete collection of the innumerable organic compounds required for research, like that previously held in Germany, a very considerable number of such compounds of British manufacture are now offered through trade channels.

British manufacturers should be encouraged to go on adding to their collection, temporarily supplementing it as may be necessary by purchasing abroad. Research chemicals being required in very small amounts, it cannot pay the manufacturers to continue their efforts unless they receive a large body of support.

The development of British chemistry is aided by any steps which result in giving employment and openings for more chemists. The extension of our chemical industries, especially in the domain of organic chemistry, helps not only by attracting to the profession men of ability who in the choice of a career must be guided by opportunities for useful service with good remuneration, but it helps also by supplying a good training ground for the graduated student who otherwise would not find the right opportunity for specialisation.

Chemists find employment in the organic chemical industry in great numbers because of the variety of ways in which they are needed. Complex reactions of the type involved must be controlled in every stage of manufacture by a chemist. Even old-established processes call for continued investigations both for the purpose of improving them and for grappling with new difficulties which are continually arising. There are also in every large works research, analytical, and process-control laboratories, in each of which young men are engaged under competent direction. These laboratories constitute a very valuable training ground for chemists, who in reality always acquire an important proportion of their chemical knowledge during the years following the completion of their university curricula. With the expansion of the fine chemical industry there would be fewer of those cases where young men of great talent have given up their career in chemistry because the opportunities were so few and the prospects so poor.

The general effect of expanding chemical industry will be to enhance the status of chemical science in this country. The academic life of a people is profoundly affected by the national industries, and any measures designed to foster and preserve those industries which call for the greatest exercise of scientific knowledge and skill are, therefore, closely concerned also with purely scientific studies. It is largely on this account that we give our support to action which will help to safeguard the fine chemical industry in this country.

A Physical Theory of the Universe.

Space, Time, and Gravitation: An Outline of the General Relativity Theory. By Prof. A. S. Eddington. Pp. vii+218. (Cambridge: At the University Press, 1920.) Price 15*s*. net.

"THE mind is not content to leave scientific truth in a dry husk of mathematical symbols, and demands that it shall be alloyed with familiar images. The mathematician, who handles x so lightly, may fairly be asked to state, not indeed the inscrutable meaning of x in Nature, but the meaning which x conveys to *him*."

This is a quotation from the preface to the work now before us, and it aptly summarises the author's task. It is a commonplace to say that no modern development of scientific thought has evoked such a widespread attempt on the part of the layman to understand its import. It would be equally true to say that no other development ever contained within itself such formidable barriers to comprehension. For the theory of relativity, in its general form, deals with conceptions which have had no place in the usual mode of thought, and a large part of our mental scaffolding must be pulled down before we are in a condition to attempt to form a picture of the external world which shall satisfy us as our older pictures have done. Other treatises on the subject now exist, but none which proposes, without the use of symbols beyond the simplest type and in small number, to tell us what x conveys to a relativist. This is the task of Prof. Eddington, who has already done more than any other authority in this country to clarify the whole subject, and to reduce it from a somewhat arid desert of mathematical symbolism, of a type unfamiliar even to most mathematicians, to something which can appeal to the mind of one used to the concepts of physics. This work is an attempt to make the appeal yet more general in its scope, and at the outset we should say that it is difficult to imagine a greater degree of success possible in regard to such a theory. As it leaves the pen of the author, this theory, while yet the same, is scarcely recognisable as the same, for in place of a scheme of pure mathematics we now have a fully developed physical theory of the universe expressed in physical terms.

The reader is first presented with a symposium —between an experimental physicist, a pure mathematician, and a relativist, who discuss the nature of space and of geometry—which brings out vividly the defects of our mental scaffolding in so far as it consists of ideas of space and time. He passes to the Michelson-Morley experiment and the FitzGerald contraction of matter in the direction of its motion. These are now almost matters of general knowledge. But there is a wealth of illustration from everyday events to give point to rather recondite or merely unusual ideas. The confusion of the aviator and his spectator, with their cigars, on pp. 24–25, cannot well fail to give to any reader, in a humorous way, an exact idea of a great part of the simpler restricted principle of relativity; and this type of illustration, which at once captures the mind, abounds throughout. It is made quite clear that in accepting this principle we are merely giving up some unproved and unprovable hypotheses which are an actual barrier to the comprehension of Nature.

The principle itself follows, with a survey of æthers of various historical types, and a general summary of the reasons which make the principle necessary. We do not, in this review, give any account of the theory itself. The world of four dimensions follows, and of this it is sufficient to say that it will probably focus the reader's interest more than anything else, and that it is by far the best realisation of the analysis into ordinary prose —if the author's vivid prose is ordinary—which we have seen or imagined. It is a relief to find that the author does not enter, or deem it useful to enter, into metaphysical speculations on the meaning of "imaginary time" as it appears in the Minkowskian world, but frankly descends to real time for his exposition.

After chapters on fields of force and types of space, we come to a comparison of the new and the old laws of gravitation. To a mathematician or physicist called upon by his lay friends to explain, several times in a week, just what awful fate has overtaken Euclid and Newton, this discussion seems completely indispensable, for the author has found words in which to express the matter to a lay friend, and such words have always failed the reviewer and probably many others. Included is a simple indication of the nature of the calculation—of deflection of light by the field of the sun—which observers, including Prof. Eddington, went far afield to test.

Much space could be occupied by a mere table of contents of this volume. Every aspect of the theory is touched upon, and all the alternative interpretations of the phenomena which have at various times been suggested receive due and fair consideration. We have a clear statement on all such points as "mass is a measure of energy," and so forth, which puzzle the uninitiated. The "weight of light" has a chapter to itself. The final chapter is of a highly metaphysical type, to follow on the conclusion of the theory. Apparently addressed to philosophers, we can see it raising many heated controversies. Perhaps we may, as we began with a quotation, also end with one—the penultimate paragraph of this chapter :—

"The theory of relativity has passed in review the whole subject-matter of physics. It has unified the great laws, which by the precision of their formulation and the exactness of their application have won the proud place in human knowledge which physical science holds to-day. And yet, in regard to the nature of things, this knowledge is only an empty shell—a form of symbols. It is knowledge of structural form, and not knowledge of content. All through the physical world runs that unknown content which must surely be the stuff of our consciousness. Here is a hint of aspects deep within the world of physics, and yet unattainable by the methods of physics. And, moreover, we have found that where science has progressed the farthest, the mind has but regained from Nature that which the mind has put into Nature."

A disappointing conclusion, perhaps, to many —but we congratulate the author on the way he has dealt with a task all the harder because the results read so easily and simply; we also congratulate the Cambridge University Press on the technical excellence of the volume, which is everything that we usually associate with the series to which this work belongs.

J. W. N.

The Methods of Cancer Research.

Some Conclusions on Cancer. By Dr. Charles Creighton. Pp. xiii + 365. (London: Williams and Norgate, 1920.) Price 42s. net.

"THERE is something common to all tumour-malignancies, which I take to be cells feeding on the substance of blood to their own aggrandisement, instead of metabolising it, storing it, or transmitting it to an ulterior end. But that risk arises in various ways. In all cases there must be an unfortunate occurrence of a number of factors, of which one may be prerogative in one case, another prerogative in another" (p. 83).

In these words Dr. Creighton summarises his conclusions on the nature and mode of origin of cancer. It is necessary to add that the cells involved are only rarely the cells of the specific parenchyma of the organ in which cancer arises. In most cases they are endothelial cells or plasma cells. The apparent reproduction of the structure of the specific parenchyma in the cells of the new growth is a mimicry, a pseudo-differentiation which it may at once be confessed has deceived three generations of pathologists. Metastases arise by a similar transformation of cells of distant organs, and not by embolism as currently believed. The similarity in structure to the primary growth which they present is mysterious —"mystical"—and no explanation is offered or suggested.

The credibility of a hypothesis is judged by the number of different observations which it harmonises: its utility by its power to suggest new methods and lines of work. In both directions Dr. Creighton's book is of little value. The author recognises that his views do not harmonise with the observations of others. He has a short way with them. The other observers are wrong. This is particularly well exemplified in his discussion of the histogenesis of carcinoma of stratified squamous epithelium. It is stated to arise from cells of a cambium layer lying between the basal layer of the stratum Malpighii and the corium in squamous cell carcinoma of the skin and tongue. In the œsophagus the same type of growth arises from capillary loops which penetrate the superjacent squamous epithelium. The evidence for these remarkable statements is based on rough semi-diagrammatic figures of large growths, several of which are ulcerated. A laborious summary is given of the earliest work on the subject by Thiersch and Waldeyer. The beautifully illustrated monographs of Ribbert and Borrmann on the same subject, in which new growths of microscopic size are analysed, almost cell by cell, are not mentioned. There is one short reference to the confirmatory work of Butlin in this country. The whole argumentation is irrelevant, and does not shake in the least the evidence that squamous cell carcinoma arises in minute circumscribed areas in stratified squamous epithelium. Once the primary transformation has been accomplished, no evidence can be found for increase in size by transformation of surrounding cells into cancer.

The origin of metastases is dealt with in the same way. Large nodules with vascular connections with the surrounding tissues are adduced in illustration of a transformation of the surrounding cells into new growth. The earliest stages in which cancer cells lie among unaltered blood corpuscles, such as are familiar to every working pathologist, are unknown to the author. The confirmatory evidence furnished by the experimental reproduction of blood-stream metastasis and by subcutaneous inoculation of cancer in laboratory animals is too damning to ignore, and a chapter and a half are devoted to the subject of "mouse-cancer." Here the author is completely out of his depth. Where the facts are too patent, they are passed over in silence or simply contradicted, as, for example, the absence of cancer in selected families inbred for generations, and the occurrence of cancer in female mice which have never borne young and in wild mice.

The origin of grafted tumours from introduced cells is denied, and the figures in which the continuity is traced day by day are described as showing an origin from nuclear débris lying in a formless mass of disorganised protoplasm. The adjacent intact cells in which mitosis proceeds are regarded as having nothing to do with the formation of the new tumour. The general confirmation in the rat, rabbit, guinea-pig, and dog of the observations on new growths of the mouse is not even mentioned.

It is unnecessary to review in detail the other chapters on chorion-epithelioma, glioma, cancer of the mamma, stomach, and rectum. It is only too evident that the author has approached the subject with vague preconceived ideas, any illustration of which can be made to function as rhetorical proof. As he naïvely remarks in the preface, "he can imagine nothing better for the future progress of these studies than that others, bringing their own prepossessions, should resort to the same cabinets [of slides in the pathological department of a great hospital] to find in the infinite variety of phenomena the proofs which they seek." As may easily be imagined, a work conscientiously written throughout in this spirit contains little that is suggestive for new investigations, whether histogenetic or experimental, and in this direction also the book fails of justification.

Cancer research, in addition to its occupation with the empirical treatment of the disease, is concerned with the answer to two questions. In what way do cancer cells differ from cells of the same kind which are not cancerous? What are the changes by which ordinary cells become cancerous? At present our knowledge only suffices to give the most general and superficial answer to the first question, and to the second no answer as yet can be given. In the unvarying parenchymata of transplantable tumours we possess an ideal material for investigating the first of these problems and for testing hypotheses framed to solve it. The advances which are even now being made in the experimental production of cancer are providing the means for a rational attack on the second. The time has come when speculation and hypothesis must take their proper place as servants in the investigation of cancer, not substitutes for observation, experiment, and proof.

J. A. MURRAY.

Virgil's Botany.

The Trees, Shrubs, and Plants of Virgil. By John Sargeaunt. Pp. vii+149. (Oxford: B. H. Blackwell, 1920.) Price 6*s.* net.

THERE are many lovers of Virgil who are neither scholars nor botanists, and their number seems to be increasing, just lovers of his poetry, who are content without any great knowledge of grammatical criticism—content with translating *quercus* and *robur* by the same word "oak," for whom *taeda, picea, pinus, abies* are equally "fir" or "pine," though they would, for the most part, hesitate to affirm on the authority of Gallus that "Violets are black and blaeberries (*vaccinia*) too." To all such the book now before us, written by a former master at Westminster, who grows Virgilian plants in his English garden, and has travelled in Italy, comes with the promise of help. We hope with its aid to attain to a better understanding and, therefore, to a truer appreciation of the poems, especially of the "Eclogues" and "Georgics," the country poems. And at first we are not disappointed.

It is true that we have to get over the initial difficulty of the title; for are not trees and shrubs plants too? Why not say "herbs"? It is as though we were to write of men and animals. Letting that pass, however, we find a very interesting introductory chapter, which deals with the geography and the distribution of plants in the valley of the Po two thousand years ago: what enormous changes, natural and artificial, have been wrought in the intervening years, turning Gallia Cisalpina of Virgil's day into Lombardy of our own!—the wolf no longer descends from the dense forests of the Apennines to ravage the flocks; the olive now flourishes on the shores of Benacus. Then we come to a very interesting discussion of the colours mentioned by Virgil—*purpureus* and *ferrugineus*, *niger* and *ater*, *candidus* and *albus*, *flavus*, *luteus* and *fulvus*; the particularly elusive *caeruleus* is, however, not mentioned, and it is a pity that when fields of ripe corn, yellow sands, auburn hair, gold are given as examples of objects to which the colour *flavus* is attributed, *flava oliva* is not given too. The subject of these colour names is a very obscure one. We know very little about it, and that "in some contexts white means little more than not black and black little more than not white" is wisely said. Might not the saying be further extended? Do not we, on the other hand, very often insist too minutely on the differentiation and discrimination of natural colours and of colour names? People have been known to fall out and almost to quarrel over the colour of autumn saffron, *Colchicum autumnale*: is it pink or is it mauve? What is mauve?

But when we pass from the introduction to the body of the book we are disappointed: it is full of solid and valuable information, but the many inaccuracies, some of which are so obvious that a very slightly informed reader can scarcely fail to detect them, rob it of a great part of its value and inspire a strong mistrust of even the better part.

P. 66. The true laurel is the bay (*Laurus nobilis*), from which we get camphor and cinnamon.

P. 97. The capsules [of *Papaver somniferum*] abound in opium or hashish.

Less obvious at a first reading are the wrong attribution of Acanthus to the Scrophularineæ (not Scrofularineæ); the statement (p. 37) that the purple crocuses of our gardens are *Crocus versicolor*, whereas they are *C. vernus*; and the confusion (p. 137) between Viscum, our mistletoe, and Loranthus, which, according to Arcangeli, grows on oaks and chestnuts.

What can be the meaning (p. 91) of: "The victors in the games are crowned with olive blossoms, which drop upon their yellow pollen" ("Æ." v. 309)? The line in the original is: . . . *flavaque caput nectentur oliva.* And why should the foliage of both the olive and the oleaster be called "heavy"? Is this a misprint for "hoary"?

Florentes ferulas et grandia lilia quassans: this is said of Silvanus and not of Pan—of Silvanus, *agresti capitis honore,* crowned with a wreath of oak leaves, and bearing in his hand, brandishing, *quassans,* flowering ferules and tall white lilies, leading in a train of weeping nymphs to Pan, over whose ruddled face the bloody juice of the dwarf elderberries trickles down. Cannot we see them all? *Panaque, Silvanumque senem, Nymphasque sorores.*

No. The book is not what we had hoped for, a safe guide, a trustworthy friend, a welcome companion, in the study or in the garden; it is disappointing. Such a book is needed—it has yet to be written. Why should not the author of this one write it? Here he has the first sketch of it, the half-carved block; the design is good, the material is good, they are worthy of further work. On his title-page he tells us that he was prompted by *tantus amor florum*; let him not omit to carry plenty of *suburra,* and he will be amply rewarded by the *generandi gloria mellis.*

G. H. W.

Our Bookshelf.

William Sutherland: A Biography. By Prof. W. A. Osborne. Pp. 102. (Melbourne: Lothian Book Publishing Co. Pty., Ltd.; London: The *British Australasian,* 1920.) Price 7*s.* 6*d.*

THE friends of the late William Sutherland will welcome this little biography by Prof. Osborne. It is a faithful portrait of the man charmingly conveyed by a judicious selection of incidents from his life. William Sutherland's was a remarkable character, and he was an unexpected product of a new country, where a leisured class scarcely exists. This biographer has done justice to his extraordinary versatility and modesty. Many who valued his society on account of his knowledge and appreciation of literature, painting, and music will, no doubt, be surprised to learn from his biography that he possessed a world-wide reputation as an investigator in molecular physics, and was the author of upwards of fifty papers dealing with some of the fundamental properties of matter.

Sutherland had no private fortune, but, nevertheless, abstained from devoting more of his time to earning money than was necessary. Occasional work for the Press and infrequent examinerships produced sufficient income to supply his modest needs. This peculiarity kept him from accepting permanent academic posts. It is a matter for regret, however, that a small chair, which would have provided him with a laboratory, and brought him into contact with students, was not available for him. The value of the work he did with such devotion would have been enhanced thereby, and what a gain his inspiration would have been to any institution!

At the end of the volume Prof. Osborne has gracefully referred to Sutherland's saintliness. This is no exaggeration of his biographer. Although I loved him well and sought his society frequently, I was never quite comfortable in it because he was so singularly devoid of vices and so tolerant of other people's weaknesses. Notwithstanding his delightful sense of humour, it was scarcely more possible for us to attain complete harmony than for a drunkard to be quite at ease in the society of a teetotaler.

C. J. MARTIN.

Maryland Geological Survey: Cambrian and Ordovician. Pp. 424 + lviii plates. (Baltimore: The Johns Hopkins Press, 1919.)

THE Maryland Geological Survey has always been noted for the educational aspect of its publications, which are by no means a dry record of observations for the use of scientific specialists. They help the ordinary citizen to understand his State, and in so doing to appreciate the aims and methods of research. The results of much careful work in petrology and palæontology are brought together in the well-known green-covered volumes, so as to be accessible in private libraries and in schools. The present volume, by R. S. Bassler, covers a part of the Atlantic slope from the crest of the Alleghanies to the sea, thus including the three great belts of contrasted scenery that stretch from New England to Mississippi. The British controversy as to the nomenclature of the older Palæozoic systems is interestingly re-stated, and the author, on grounds of fairness to the original workers, would like to use Taconic and Cambrian for the systems now styled Cambrian and Ordovician respectively. He effects a proper compromise, however, and fairly discusses Ulrich's Ozarkian and Canadian systems.

There is certainly no "writing down" to a popular level in the stratigraphical and palæontological descriptions, though in one place, in a sketch of the life-processes of Cryptozoon, "lime" is accidentally used for "calcium carbonate." The results of investigations in other fields are brought together, and local fossils are illustrated by notable specimens, such as *Olenellus Thompsoni* from Vermont, which add interest to those already found in Maryland. Cryptozoon occurs in the Cambrian and Ordovician of Maryland, and its algal nature seems to be established, though the Cambrian fauna is generally poor. Does the author refer to this fact when he makes the general statement on p. 32 that the Pelecypoda appear for the first time in Ordovician strata?

The numerous photographs of wayside sections and rolling farmland country are a pleasing feature. Plate ii. shows, from the Virginian side, the fine gorge of the Potomac cut across the Cambrian sandstones at Harper's Ferry, a scene known alike to history, geography, and geology.

G. A. J. C.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

A Quantum Theory of Vision.

IN a paper appearing in the February issue of the *Philosophical Magazine* I have described a theory of vision which ascribes visual stimuli to the activity of light quanta in liberating electrons from the visual purple. Various phenomena associated with scotopic and photopic vision are considered. Those coming under the designation of simultaneous contrast did not appear to me, at the time of writing, referable to purely retinal actions. Since then it has occurred to me that simultaneous contrast effects find explanation in a very simple way on the same data as serve to explain successive contrast, *i.e.* in the external location of the sensitiser with reference to the cones and in the motion of these organs attending light stimulus.

Consider the case of a grey patch bordered by a black area. This disposition secures unused sensitiser around the retinal image of the central patch. When those cones which are covered by the image of this central patch retract, the unused sensitiser flows in around them. The conditions are, therefore, favourable to specially luminous sensation, and the grey patch looks bright. In the other case, when the grey patch is surrounded by a white area, the reverse conditions prevail. The retreat of the cones involves the inflow of used-up sensitiser around the cones covered by the central image. The conditions are favourable to lowered luminous sensation, and the grey area looks dark. When we substitute for the white border a coloured border, then the sensitiser invading the central area of the retinal image is "fatigued" for the particular tint of the border, and hence the central grey looks tinted with the complementary colour. The tissue-paper, which when laid over the patches accentuates these effects, acts probably in two ways. It renders good fixation impossible and, by the increased luminosity which it brings in, it causes the cone-movements to become more active.

In my paper I have invoked the "latent image" familiar to photographers. I think it explains more even than I claimed for it.

The latent image in the photographic plate may be ascribed to electrons which, having travelled a certain distance from their point of origin, become loosely attached to atoms. Afterwards they take part in the chemical effects attending development, or, if exposure is carried so far as to cause an accumulation of electrons to the point of instability under increasing electrostatic forces, the latent image runs down of itself. This is "solarisation" or "reversal." There may be a succession of such reversals under continued exposure.

It is quite to be expected that something of this sort will occur in the case of the cones, and possibly of the rods also. After-images find explanation in this way, and their theory becomes very complete when the motion of the cones under light stimulus is taken into account. As briefly referred to in my paper, the latent image serves also to explain the "dark" electrical response of the retina—a response which has the same sign as the "light" response. To understand this we have to consider that the latent image in the nerve-substance has less stability, very probably, than that which forms in the photographic plate, owing to the nature of the medium. It is probably kept in being by the continuous inflow of electrons from without the cone, and, normally, is also continually breaking down. When light is cut off, the whole accumulation runs down, attracted back to the positively charged ions developed around the cone. Hence there is a second stimulus, and it will, of course, be of the same sign as that attending the primary movement of the electrons. The final discharge of the latent image may be relatively slow, as the curves in some cases show. Looking at such a curve as that which Piper obtained for a pigeon's eye under brief periods of darkness alternating with light intervals, it needs little imagination to picture the happening of these events.

Fröhlich's results on the Cephalopod eye seem to involve the same effects. In this case the latent image builds up rapidly within the rods which are exposed directly to the light and as rapidly runs down, giving rise to rhythmic electrical responses from 20 to 100 per second. Just on account of this extreme instability of the latent image there is no definite dark response. In short, the dark response is a phenomenon connected entirely with the quasi-stability of the latent image, and is probably favoured by the location of the sensitiser external to the nerve.

From all this I think we must conclude that the stimulus is ascribable ultimately to the motion of the electron, its amount depending upon the kinetic energy, and this, in turn, upon the particular quantum which activates the electron. The return of the electron in some cases, under the electrostatic attraction at the point of origin, involves a fresh stimulus. This is a phenomenon similar to that which Lenard invokes in his explanation of phosphorescence.

On this view colour is appreciated in terms of the energy of the stimuli; brightness in terms of the concentration or density of the stimuli. Rhythmic succession of stimuli is not required, and does not exist. It will be understood that this theory does not involve views respecting the origin of the quantum. Thus, whether we believe that quanta originate at the source of light or come into existence upon its absorption—as Sir Oliver Lodge has suggested—the basis of the theory remains. The one thing essential is the relation between the energy of the photo-electron and the frequency of the light which gives rise to it.

I conclude with a question: Are there any good data available respecting the rate of motion of the cones under light stimulus? It is generally stated that it is slow even with strong lights (and faster for violet than for red). Definite information on this point seems worth seeking. For if the reaction towards the light were rapid, we could regard it as diminishing the effects of dispersion in the refractive system. It is probable (in harmony with the present theory) that the displacement would be greater for violet than for red rays. This would tend to bring cones illuminated by violet light nearer to the lens than cones illuminated by red light. There would be at least a partial correction for dispersion.

J. JOLY.

Trinity College, Dublin,
January 30.

The Constitution of Lithium.

POSITIVE rays of the alkali metals were first obtained by Gehrcke and Reichenheim by using as anode a heated metal strip upon which a suitable salt was melted. Later they substituted for this a specially constructed composite anode which yielded the rays without the necessity of external heating.

Both these methods have been employed recently at the Cavendish Laboratory to investigate the constitution of lithium, the rays produced being analysed by Sir J. J. Thomson's "parabola" method which gives ample resolving power for this element.

By means of the composite anode (G. P. Thomson, Proc. Camb. Phil. Soc., vol. xx., p. 211, 1920) a number of plates were taken showing in several cases double parabolas corresponding to 6 and 7, but owing to the fact that spurious doubling had occasionally occurred, due to instrumental trouble, publication was withheld.

It has now been found possible to apply the externally heated anode, employed by Dempster in 1918 for potentials of about 1000 volts, to high potential rays. This arrangement is used at very low pressures, and under these conditions *metallic rays only* appear to be produced.

Exceedingly satisfactory parabolas corresponding to lithium have been obtained, a strong one at 7 and a faint companion at 6 (Na=23). The intensity of the latter appears to correspond well with the accepted atomic weight 6·94.

The foregoing results appear to leave no doubt that lithium is a complex element with isotopes of atomic weights 6 and 7. Of course, no accuracy can be claimed for these figures until higher resolution has been applied, but there seems no reason to doubt that they are very nearly whole numbers.

F. W. ASTON.
G. P. THOMSON.

Cavendish Laboratory,
February.

The Elementary Particle of Positive Electricity.

THE name "negative electron" was applied to the elementary particle of negative electricity after the experimental evidence for the variation of its mass with velocity had generally convinced physicists that its whole inertia was due to its electric charge. This meaning of the term "electron" was in accord with Dr. Johnstone Stoney's original use of the word to denote the elementary unit of electric charge. With the introduction of the principle of relativity it became clear that the variation of mass with velocity was no characteristic attribute of electrical inertia, and that therefore we have no proof that the negative electron's inertia is wholly electromagnetic in origin. In fact, the investigations of Abraham, Webster, and others have shown that there must be some mass present other than that due to the electron's electric field. If we abide by Dr. Stoney's original meaning of the word, it is therefore more than doubtful whether we are justified in calling this negatively electrified particle of matter an electron. Nevertheless, the term is now so well established in the literature that we use "electron" to denote this elementary particle regardless of our view concerning the origin of its mass.

The arguments for and against the electrical origin of the mass apply in exactly the same manner to the elementary particle of positive as to the corresponding particle of negative electricity. If the negative particle can legitimately be termed an "electron," it is thus equally legitimate to apply the term to the positive particle, since it likewise carries the fundamental unit of electric charge. Why not, therefore, denote both these elementary particles by the same generic term "electron," distinguishing the "positive" from the "negative" electrons when necessary, as several writers have long been accustomed to do?

It seems to me that the application of a distinctive name, such as "proton" or "hylon" or "hydrion," to the elementary particle of positive electricity can only suggest a distinction between the nature of the positive and negative electrons, which, so far as we are aware, does not exist. Thus, for example, when an atom of hydrogen is split into its two components the negative electron is just as really a hydrogen ion as is the positive electron. The fact that both components possess equally fundamental units of electric charge and are equally fundamental divisions of matter should suggest that the same generic name "electron" be applied to each.

ARTHUR H. COMPTON.

Washington University,
St. Louis, U.S.A.,
January 25.

The Peltier Effect and Low-Temperature Research.

I SHOULD like to inquire whether the Peltier effect has ever been considered as an aid to the production of very low temperatures. I understand that the lowest temperatures yet obtained are those produced by Dr. H. K. Onnes, of Leyden, who, by reducing the temperature of metals to that of liquid helium, has got down to within less than 4° of the absolute zero of temperature, or more than 450° below zero Fahrenheit. Onnes, moreover, found that at such a temperature pure metals lose practically all electrical resistance and become nearly perfect conductors.

The suggestion is to apply the Peltier effect, which consists in an observed diminution in temperature when an electric current is passed in a particular direction through a thermo-couple to obtain still lower temperatures.

At ordinary temperatures, when the metals composing the thermo-couple have appreciable resistance, the Peltier effect is largely masked by the C^2R heat produced in the metals by the passage of the current. At the temperatures attained by Onnes, when resistance practically vanishes, this condition should not obtain, with the result that the application of the Peltier effect would appear to give possibilities of obtaining materially lower temperatures than have yet been reached. A. A. CAMPBELL SWINTON.

66 Victoria Street,
London, S.W.1,
February 16.

Heredity and Biological Terms.

IT seems to me that the arguments of Sir Archdall Reid (NATURE, February 3, p. 726) and Sir Bryan Donkin (February 10, p. 758) leave the question of the meaning and use of the term "acquired characters" very much where it was before. Sir Bryan Donkin asks whether it may not be justly argued that if a child has a hand like its parent there is no change in "nature" or "nurture"; that if the child has a sixth digit which the parent had not there is a change in nature or heritage, but none in nurture; and that if the child has a scar there is no change in heritage, but only one in nurture. But I fail to perceive anything new in this or any difference from the usual conceptions which are general among biologists. It is a mere matter of terms and synonyms. The modern biologist would say that the normal hand was hereditary, or innate, or due to certain factors or genes in the chromosomes which usually are handed on unchanged "down the germ-tract"; that the sixth digit was a mutation, due to some change in the genes in the chromosomes, and therefore gametogenic; and that the scar was due to an injury which resulted in regenerative processes producing new tissue. Sir Bryan Donkin states that the scar is an "acquired difference," but in terms of the germ-plasm the hand and the scar indicate no change. What, then, is the objection to terming the scar an "acquired character"? Every biologist would agree that it does not indicate a change in the chromosomes. Its possible subsequent effect on heredity is expressly excluded from the discussion.

Yet Sir Bryan Donkin insists that the division of human characters into two groups, "innate" or "acquired," "constitutional" or "environmental," is a cause of much confusion—apparently because, as Sir Archdall Reid insists, "a vague terminology has caused neglect of the evolution of the power of developing in response to functional activity." But, so far as I know, that writer has produced no evidence of such an evolution, no evidence that functional activity has more effect in the higher animals than in the lower. It is difficult to think of cases of different functional activity among individuals in lower animals, but if we take conditions such as quantity and quality of food, we know that the difference between worker bees and queen bees is entirely due to this difference of "nurture"—in fact, is an "acquired character." Probably Sir Archdall Reid would consider insects as lower than man, though biologists would not admit that he was right. Sir Bryan Donkin writes that like exactly begets like when parent and child develop under like conditions; if we say, then, that the differences due to unlike conditions are acquired characters, what is the objection?

In my previous letter (January 13, p. 630) I criticised some of Sir Archdall Reid's statements by pointing out that they contradicted each other. In reply he referred to some supposed views as to what were acquired characters put forward in other publications of mine. But he is not entitled to do this. I made no offer to discuss my own views; I was merely criticising the arguments by which he attempted to show that all characters were "innate and acquired in exactly the same sense and degree." What I may have written elsewhere is not relevant to the present discussion. In the letter in the issue of NATURE for February 3, Sir Archdall Reid takes the case of a normal Englishman and a scarred negro as an example, and states that they differ in scars by acquirement, but that the scars are not acquired any more or less than the skin-colour. It follows, then, either that an acquirement is not acquired or that the skin-colour is also acquired in the same sense and degree as the scars. But the latter is not the case, for the different skin-colours will develop under the same conditions—that is, they do not correspond to different conditions, while the scars are related to a difference of conditions or stimuli, namely, injury in the one case which is absent in the other. If Sir Archdall Reid means that no character could be acquired unless the living substance of the organism had the potentiality of developing in a certain way under certain conditions or under a certain stimulus, that is, of course, a truism which does not require to be stated. But he has entirely failed to prove that all characters are innate and acquired, somatic and germinal, exactly in the same sense and degree. His own arguments and examples prove the contrary.

J. T. CUNNINGHAM.

Coloured Thinking.

IN view of Prof. Fraser Harris's letter in NATURE of February 3 and of his implied complaint that so little has been written on the phenomenon since Galton discovered it, possibly the record of some observations that I made upon my own son more than eleven years ago, when he was between seven and a half and eight years old, may be worth notice. I was in correspondence with Galton about the case shortly before his death; and, in fact, a letter to him, reporting the result of further inquiries suggested by him, was lying on my desk ready to be posted when I opened the daily paper and read the announcement of his death.

Having accidentally discovered that my son had coloured concepts, I noted down a series of these in the late autumn of 1909, taking great care to avoid any approach to leading questions or suggestions. Then, three months later, having meantime ignored the matter, I again tested him; and on this occasion, at Galton's suggestion, I carried the inquiry rather further. I will deal first with the numerals, since these afforded the most interesting results. Their colours were:

	In 1909	In 1910
1	Any sort of colour.	Black.
2	,, ,, ,, ,,	Brown.
3	(Not noted.)	White.
4	Blue.	Blue.
5	Yellowish.	Yellow.
6	White.	White.
7	Red.	Pink.
8	Rather dark red.	Red.
9	Greenish.	Green.
10	Black.	Not asked
11	Brown.	,, ,,
12	Blackish-grey.	,, ,,
35	Not asked.	White and yellow.
36	,, ,,	White and white.
55	,, ,,	Yellow and yellow.
80	,, ,,	Red.
800	,, ,,	Red.
100	,, ,,	Black.

On the second occasion I tested the obvious inference from his description of the colours of 35, 36, and 55, by asking him the colours of 49, 72, and 14; and my notes state that he made "ready replies."

49 was blue and green.
72 ,, pink and brown.
14 ,, black and blue.

I had already noted his statement that the colours of 35, 36, and 55, were "in their proper order."

Now obviously there is a marked difference between the colours of the numerals above 19—or possibly above 10—in this case and those seen by Miss A. M.; for she sees apparently all the twenties, thirties, forties, etc., in the colour of the first digit; whereas my son saw each digit in its own colour and unaffected by the combination with another. The deliberate tests with 49, 72, and 14, following his account of 35, 36, and 55, and the remark about the "proper order" of the colours, were conclusive on this point.

There is another matter of interest. Having told me the colour of 8 already, he was surprised at my asking the colours of 80 and 800, and replied that of course they were the same as 8. In other words, the zero was really zero to him, and therefore had no colour. Now in teaching him arithmetic during the preceding months I had endeavoured to make him realise that the value of a digit depended upon its position, and that the zero was simply a shorthand symbol for an empty place. His coloured thinking satisfied me that I had completely succeeded, and that the cipher 0 was really *nothing* to him.

I note that Miss A. M. sees 20, 30, 40, etc., coloured as 2, 3, 4, etc.; but since, apparently, 20–29 are coloured as 2, 30–39 as 3, and so on, there is no such inference possible in her case. It would, however, be of interest to learn whether she sees 0 coloured or not.

There was one exception to this nonentity of zeros in my son's mind; for he described 1000 as always yellow, adding that "it ought to be black really [*i.e.* the colour of 1], but it is not; that's the funny thing; it does not come in proper order." My interpretation was that a thousand seemed to him something so big and important that it stood by itself and rather out of relation to the lower numbers; and I suspect that, had he known it only as "ten hundred," it would have been duly black.

It will be observed that, although on the earlier occasion he gave no specific colours to 1 and 2, yet his colours for 10, 11, and 12 accorded pretty well with the colours assigned on the second occasion to 1 and 2. Otherwise there is no discrepancy between the two records.

I obtained from him also the colours of the points of the compass, of the names of various towns and countries, and of sundry other names; but too much space would be occupied by the account and discussion of these. He told me that "nearly everything I can think of is coloured."

My daughter similarly has coloured concepts; but she has also what I do not remember ever to have seen described in anyone else until I read Prof. Harris's letter, and that is *coloured tastes*. I think, too, that tastes are more strongly coloured for her than for Miss A. M. She has frequently, to our amusement, spoken of things having "a mauve taste"; and when we were discussing coloured thinking last vacation she remarked that "of course all tastes are coloured."

Prof. Harris emphasises the normally hereditary character of coloured thinking. A few words have always been coloured for me, and in a vague and misty way many probably are; but if I try to see (mentally) what precisely the colours are, I cannot succeed. It seems rather as though some words had polished or glittering surfaces, or a sheen, and reflected light, while others were sombre and light-absorbent. When I read Galton's book about thirty years ago I realised that I saw the numerals in a psychogram.

My wife, after declaring that coloured thinking was utterly unintelligible to her, mentioned that, of course, the vowels are coloured, and that she had supposed they were for everyone, but that the consonants are not. It appears, therefore, that my children started from a slight, but twofold, hereditary tendency to coloured thinking. FRANK H. PERRYCOSTE.

Polperro, Cornwall, February 12.

The Effects of Oil from Ships on Certain Sea-birds.

SIR ARTHUR E. SHIPLEY has recently directed attention to the probable effects upon our fisheries of the discharge of oil from ships into the sea. I should like to refer to another side of this matter, viz. the effects upon certain species of sea-birds.

For our present purpose we may divide sea-birds into three groups according to the number of eggs they hatch per season, and, further, in each group we may distinguish certain species as divers. All, I believe, are single-brooded.

In the first group we have those species which hatch a single egg each season, such as the petrels, fulmars, sherewaters, and the razorbill, kittiwake, guillemot, little auk, puffin, etc. In the second group are the terns and the great northern and black- and red-throated divers, usually hatching two eggs per season. With the exception of the cormorant and the shag, Group 3 consists of the more littoral species (chiefly Laridæ), which produce three or more eggs per season, and scarcely bear upon the present subject.

During the past five years large numbers of those species which dive beneath the surface of the water in order to obtain their food have been washed up on the Fife coast and elsewhere dead or in a dying condition and covered with a thick coating of oil. The actual total of dead birds must be enormous. In one day we counted more than 300 kittiwakes and almost the same number of razorbills and guillemots, and dozens of little auks and puffins, and this is of frequent occurrence. On the west sands at St. Andrews in October last dozens of dead gannets in a similar condition were washed ashore. Even admitting that these represent a concentration from a great sea area, the oft-repeated occurrence indicates a new factor of disturbance which is proving inimical to a large percentage of these birds. If this continues, or the disturbing factor grows more serious, the possibility of the extermination of such species seems not at all unlikely.

It is a generally accepted biological principle that the rate of reproduction of a species is a character very slow to change, and in the case of slow breeders, such as the species here referred to, any unusual factor leading to a higher rate of mortality can only lead to very serious consequences.

WALTER E. COLLINGE.

The University, St. Andrews.

The Annular Eclipse of the Sun on April 8.

As the annular eclipse of the sun on April 8 next may be of considerable interest to amateur observers, I am preparing a list of observations which may be made both within and without the region of annularity, and also full instructions for making the observations. Should any readers of NATURE care to suggest observations which might be made with small telescopes and the equipment generally possessed by an amateur, I should be very glad to receive their suggestions. May I also add that I am proposing to observe the eclipse from a point near the central line (probably Benbecula, in the Outer Hebrides), and if other amateurs would care to join me, would they please communicate with me with the view of forming a party? J. HARGREAVES.

The Priory, Royston, Herts, February 2.

A Rare Example of Melanism.

I WOULD like to record the occurrence of a rare case of melanism. Mr. Carl Carinus, in Rhodesia, sent me the complete skin and skeleton of an adult female oribi. It was entirely black, without any trace of white or red. The female was in the company of an adult male of normal colour.

F. W. FITZSIMONS.

Port Elizabeth Museum, Port Elizabeth,
January 27.

French Chemical Industry during the War.

IN the November–December issue of the *Bulletin de la Société d'Encouragement pour l'Industrie nationale* Prof. Haller gives a detailed and interesting account of the way in which the requirements of the fighting forces in munitions were met, and of the activities of French chemists in extending, improving, and creating processes for the manufacture of the necessary materials on the large scale.

The official policy before the war was to lay in stocks of explosives sufficient, in the judgment of the military authorities, to last out a "short, sharp war." The phenol required was obtained from Germany. In the middle of September, 1914, the use of explosives by the artillery was exceeding very considerably the amount estimated by the military authorities, and it was necessary to provide daily 40,000–50,000 75-mm. cartridges and to make schneiderite and ammonium perchlorate for trench mortars. The need for explosives continually increased, and it became evident that the character of the war was not at all like that for which the country had been prepared. A great national effort was required, and the part which the chemists of France played in this can be appreciated from the following table, giving the requirements of the Army in metric tons per day:

	Propellants	Nitrogenous explosives	Chlorate and perchlorate explosives
Mobilisation	24	0	0[1]
January 2, 1915	80	100	—
June 6, 1915	104–135	125–195	—
October 19, 1915	238–313	351–654	109–135
December 25, 1916	441–550	728–936	150–159
June 25, 1917	484–640	859–940	124–148
February 28, 1918	444	625	—

[1] Provided in stocks accumulated.

After April, 1918, the requisitions for explosives amounted to about 390 tons per day.

Sulphuric Acid.—Before the war there were 87 scattered works for the manufacture of sulphuric acid, producing 13,500,000 tons of 53° Bé. acid, of which 975,000 tons were used for the manufacture of superphosphates and the rest concentrated to 66° acid. This output was reduced by 15–20 per cent. by enemy occupation of territory. The production of explosives called for large quantities of concentrated acid, and steps were taken to force the production of the chambers from 5–6 kg. of acid per cu. m. to 7–8 kg., and to increase the Kessler and Gaillard concentrating plant in the ratio of 1 to 20. The use of acid was also restricted in industry, and nitre-cake began to be used in August, 1915. The Volvic lava of Puy-de-Dôme proved invaluable in the construction of concentrating apparatus. In addition, there were needed for the transport of acid 2000 20-ton tank wagons, 600 platforms for which were made in England and Spain.

Oleum containing 20 per cent. of sulphur trioxide was exclusively used, the consumption amounting to 1·5–1·9 tons per ton of nitrocellulose, and 2·2 tons per ton of trinitrotoluene. The oleum was, at the outbreak of war, made in a few works only, one of which, at Thann (Alsace), came under fire in 1914, and was transported by night to Saint Denis, where it was re-erected and came into operation in 1916. All the common processes (Tentelew, Grillo, and Mannheim included) were used, and a monthly output of 21,000–22,000 tons was secured. New works were put in hand, and in the meantime oleum was imported from America. The monthly consumption of sulphuric acid and oleum was as follows, in metric tons:—

	66° Bé. acid	20 per cent. oleum
February, 1915	6,000	1,000
January, 1916	42,000	5,000
January, 1917	80,000	20,000
January, 1918	60,000	19,000
June, 1918	40,000	18,000

Nitric acid was produced before the war almost exclusively from Chile nitre by the retort process, and during the war great extensions of these plants were made. The stock of nitre at the end of 1915 amounted to 90,000 tons; it increased during 1916, but from the beginning of 1917, when the submarine campaign was begun, the stocks of nitre diminished. In 1917 numerous ships laden with nitre were torpedoed. On account of the large amounts of raw material (coal, pyrites, and nitre) required in the manufacture of explosives, necessitating great shipping demands, it was decided in 1917 to ask the American Government to supply explosives ready-made. A programme was agreed upon, but the actual deliveries from America fell far short of the promises. Help was also given by Great Britain. The consumption of nitre and nitric acid (calculated as sodium nitrate) in metric tons per month was as follows:—

January, 1915,	3,600	March, 1916,	25,000
August, 1915,	9,600	July, 1917,	42,000

On account of the transport and storage difficulties it was decided to produce nitric acid by synthetic methods. These had an additional advantage, *i.e.* the economy in sulphuric acid which would otherwise be required in decomposing the nitre, which was even more important than the nitric acid. Before the war synthetic nitric acid was made by the Pauling arc process at La-Roche-de-Rame at the rate of 2 tons of 50 per cent. acid per day. This was continued, but a new factory on the Birkeland-Eyde principle was erected by the Société norvégienne de l'azote at Soulom, utilising 12,000 kw. from the hydro-electric installation in the Hautes Pyrénées of the Compagnie des chemins de fer du Midi. This works delivered 300 tons of nitric acid a month, partly as nitrates. The ammonia oxidation process was also largely used, the ammonia being derived from cyanamide. The first works was installed at the Poudrerie nationale d'Angoulême. Carbide was imported from Switzerland and converted into cyanamide by the Société des Produits azotes, nitrogen being obtained by the Claude process at Martigny, Notre-Dame de Briançon, and especially Bellegarde. From 2650 to 3500 tons of cyanamide per month were delivered at Angoulême. The first oxidation plants were operating in the autumn of 1916, and the whole were in operation in 1917. The programme was much enlarged in 1917 on account of the submarine warfare, and it was then decided to erect factories for making 500 tons of nitric acid and 150 tons of ammonium nitrate per day by the oxidation of ammonia. This programme required 800 tons of calcium carbide per day and 125,000 kw. Water-power from the Pyrenees, Central France, and the Alps, and even central steam-power plants at Nanterre and Carmaux, were brought into requisition. The most important works was at Lannemezan (50,000 kw.), and new oxidation works were installed at Toulouse, Bassens, Sorgues, and Saint Chamas. Toulouse and Bassens had begun to operate at the armistice, and the others were nearly finished. These works would have supplied all requirements in nitric acid and ammonium nitrate.

Alcohol was used, apart from minor requirements in the purification of trinitrotoluene and xylite, for the manufacture of ether for the gelatinisation of gun-cotton. Great economy was effected during the war in the latter process, the quantity of alcohol per ton of Poudre B being reduced, by solvent recovery, from 20 hl. to 8 hl. A sixty days' stock of alcohol had been accumulated and arrangements made with distillers for the regular supply of 550 hl. per day, sufficient for the estimated need of 24 tons of Poudre B. As the war proceeded, new supplies had to be obtained from the distillation of beets, molasses and cider, the saccharification of grain, horse-chestnuts and sawdust, and by recovery from stocks of confiscated absinthe and from liqueurs. Before the war the production of alcohol in France was 2,000,000 hl. per annum, with 6000 hl. of brandy per day, and was principally obtained from beets cultivated in the Départmente du Nord. The German occupation deprived the nation of this source, and there were labour difficulties. In August, 1915, the distilleries and stocks were requisitioned, and forced production was begun. From absinthe 40,000 hl. were obtained, 10,000 hl. from apples mixed with beets, and 500,000 hl. were imported from Canada and the United States. Experiments were made on synthetic alcohol from acetylene, with encouraging results. The total consumption of alcohol to (and including) 1918 was 4,713,607 hl.

Ether was made at the rate of 74 tons per day in 1915, 119 in 1916, and 166 in 1917, mostly in Government factories.

Aromatic hydrocarbons (benzene, toluene, and xylene) were used in large quantities, and their provision was one of the most difficult problems to be solved. The pre-war annual production of crude benzol from coking plants did not exceed 16,000–18,000 tons, the rest being imported from England and Germany. The yield from coking plants in occupied territory was a considerable loss during the war, and not more than 3–4 tons per day could be expected from the remaining plants, although 50 tons in 1915, and later as much as 250 tons, per day were required. Needs were supplied by the requisition of stocks, imports from England and (to a less extent) from America, the re-starting and erection of recovery ovens, extraction from town gas and from Borneo petroleum. The use in private factories was restricted, and every available means of rectification was brought into requisition. From one-third to one-fourth of the weight of crude benzol was recoverable as toluene, although the English supplies had been detoluated previous to export. Borneo petroleum was an important source (35–40 tons per day). Three fractions were obtained. The benzene fraction boiled at 80–81° C., the toluene fraction at 110–112°, and the xylene fraction at 130–132°. These fractions were nitrated and the unattacked hydrocarbons distilled off. The mononitrotoluene and mononitroxylene were converted into trinitrotoluene and xylite, the nitrobenzene being sent to the aniline factories for conversion into diphenylamine for use as a stabiliser. The production of trinitrotoluene rose from 10 tons per day in 1915 to 50 tons in 1916 and 60 tons in 1917.

Phenol and *metacresol* were used for nitro-explosives. Before the war all the phenol had been imported from Germany, and a large amount of work was necessary before the production from benzene (by fusion of sodium benzenesulphonate with caustic soda, and 2–3 tons per day from aniline by diazotisation) was in operation. The supplies of synthetic phenol (excluding relatively unimportant American imports) rose from 200 tons in 1914 to a maximum of 52,747 tons in 1917.

After the explosion in the *Liberté* in 1911, large quantities of gun-cotton were thrown into the sea outside Toulon. This was recovered in excellent condition and utilised. The two State factories of Angoulême and Moulin-Blanc were developed for the manufacture of propellants. New factories were later erected at d'Empalot (Toulouse) and Bergerac. The maximum productions of gun-cotton per day reached 120 tons at Angoulême, 38 tons at Moulin-Blanc, 140 tons at Toulouse, 100 tons at Bergerac, and 35 tons from private firms. Cotton cellulose was exclusively used. The preliminary washing and extraction of grease were carried out mainly at Angoulême, and to a less extent in paper- and dye-works. More than thirty works supplied 240 tons of cotton daily, sufficient for 360 tons of gun-cotton, which was brought up to 433 tons in 1916 by American importation. Nitration, with a mixture of nitric and sulphuric acids, was before the war carried out in pots. This method required much less apparatus than the new methods of Selwig and Thomson, which were introduced only when a crisis in the supply was feared. Pots were used at Toulouse, Angoulême, Bracqueville, and Bergerac. Angoulême later installed a Selwig plant for 60 tons, and replaced a pot installation by one using the Thomson process. The same change was effected at Bracqueville, and a Selwig plant was installed at Bergerac. The nitro-cotton, after washing, was stabilised by boiling with water, pulped, and dried to 30 per cent. moisture. Two varieties were made, CP_1 with 11 per cent. of nitrogen, soluble in a mixture of alcohol and ether, and CP_2 with 13 per cent. of nitrogen, insoluble in that mixture.

Poudre B was made by masticating the requisite proportions of these two varieties with a mixture of alcohol and ether, pressing into filaments, and drying. This was carried out at Le Bouchet, Pont-de-Buis, Ripault, Saint Médard, Sevran-Livry, Bergerac, and Toulouse. The maximum productions in tons per day from these works were 10, 48, 60, 140, 35, 60, and 130 respectively. Private industry furnished a maximum of 20 tons of ballistite (gelatinised nitro-cotton with nitroglycerin). The total production of Poudre B in France from 1914 to 1918 amounted to 306,693 tons, and 117,000 tons were during this period imported from America.

The manufacture of nitro-explosives was accompanied by strenuous endeavours to improve the methods of production and to replace these substances by others less difficult to produce. The 75-mm. shells, for example, were filled with ammonium nitrate and dinitronaphthalene; chlorates and perchlorates were introduced for filling hand grenades; and experiments were made with liquid air for charging aeroplane bombs.

The nitro-bodies picric acid and trinitrometacresol could be manufactured by known methods, but the production of trinitrotoluene, xylite, dinitrophenols, and mono- and di-nitronaphthalenes was introduced during the progress of the war. These explosives were used both alone and in the form of mixtures.

Three methods are available for the manufacture of picric acid (trinitrophenol): nitration of phenol in presence of sulphuric acid by nitric acid or sodium nitrate; chlorination of benzene, transformation of monochlorobenzene into dinitrochlorobenzene 1, 2, 4, saponification of this with formation of dinitrophenol, and trinitration of the latter; direct oxidation and nitration of benzene with nitric acid and mercury. The method of direct nitration alone was used. The second method was in use in Germany prior to the war, but as it required the use of pure chlorine it was not suited to French needs. Nevertheless, 1000 tons of chlorine were ordered from America in order to commence production in France. After the German gas attack of April 22, 1915, on the Belgian front, this chlorine was devoted to experiments on the new method of warfare. In the meantime the production of phenol had increased, and there was no longer any point in making use of the method of chlorination. The yield by the third method was poor (140 of picric acid per 100 of benzene, as compared with 190 with phenol), and the recovery of the mercury was difficult. The latter was important in view of the pressing need of mercury for the manufacture of fulminate. Picric acid so prepared may also contain small amounts of mercury picrate, which renders it very sensitive to shock.

There were three picric acid factories in operation before the war. Several chemical and dye factories in the Lyons district were requisitioned, including one of the Badische firm. State factories were also erected. Some of these factories were destroyed by explosions. The total productions of picric acid and trinitrotoluene, in tons per day, were as follows:—

Production of Trinitrotoluene in metric tons per day.

August, 1914, 0·31	January, 1917, 66·71 (maximum
August, 1915, 8·93	January, 1918, 24·02
August, 1916, 55·87	

Production of Picric Acid in metric tons per day.

August, 1915, 0·50	July, 1917, 166·1 (maximum)
January, 1916, 11·95	January, 1918, 58·86
January, 1917, 145·47	

Lack of cresol led to the use of dinitrophenol, made by nitrating phenolsulphonic acid. Picric acid was also formed, but as a mixture of the two substances was finally used, this was immaterial. The preparation by the nitration of chlorobenzene led to the installation of electrolytic chlorine apparatus producing 20 tons of chlorine per day.

The explosive *schneiderite* was used in large quantities, and was prepared by triturating in mills a dry mixture of 88 parts of ammonium nitrate and 12 parts of dinitronaphthalene. The ammonium nitrate was prepared to some extent by double decomposition of accumulated stocks of Norwegian calcium nitrate (for agricultural purposes) with ammonium sulphate, by neutralising nitric acid with ammonia solution, and by the interaction of ammonium sulphate and sodium nitrate according to a process worked out by M. Fosse, of Bordeaux, and by M. Danne, of Gif. Nearly all the ammonium nitrate, however, was imported from Norway at the rate of 200 tons per day.

Chlorate and perchlorate explosives were also manufactured. Paraffined ammonium perchlorate was tried for filling 75-mm. shells, but proved too sensitive to shock. It was, however, extensively used for trench-mortar bombs, hand grenades, and aeroplane bombs. Sodium chlorate and a mixture of 61·5 parts of ammonium perchlorate, 30 of sodium nitrate, and 8·5 of paraffin were used. The chlorates and perchlorates were made electrolytically at Cheddes, Vonges, Castres, and Grenoble, the production being 79 tons of ammonium perchlorate and 77 tons of sodium chlorate per day.

Many new products were made. Mustard gas, known as "yperite," was produced at the rate of 6 tons per day at the signing of the armistice, and plant for the manufacture of 12 tons per day was ready to be put into operation. A daily production of 24 tons was planned. Liquid nitrogen peroxide was produced at the rate of 70–80 tons per day at Angoulême, and of 25–30 tons at Bassens. It was used with a hydrocarbon in the manufacture of "anilithe" for aeroplane bombs.

Switzerland, Italy, and Spain delivered machinery and raw materials of various kinds; Chile furnished millions of tons of sodium nitrate; and Norway supplied more than 200,000 tons of ammonium nitrate. England supplied benzene, naphthalene, and coal, and America sent raw materials and finished explosives.

The tremendous strides made during the war may be appreciated from the following table, giving the productions in tons per day:—

	Before 1914	July, 1917
Poudres B	15	370
Nitro-explosives	6	700
Chlorate explosives	4	176

War-time Archæology.[1]

THE volume before us might truly be described as a "war number," for it represents not only the published work of the British School at Athens for the first regular session after the armistice, but also mainly the results of observations made while on duty by actual and former students. The seven students of the British School of Archæology who lost their lives during the war, and the school's distinguished and learned librarian, F. W. Hasluck, who died early in 1920 of a malady caused or aggravated by war service in Greece, are appropriately commemorated, and a brief summary shows the war work which fell to other students. It is a striking and varied record. If the school had done nothing beyond training for eventual public service in Greece and the Near East so large a body of men accustomed to observe accurately, handle native labourers tactfully and economically, and act with expert knowledge and executive efficiency, it would have earned many times over the miserable allowance which it receives annually from the Treasury. Special mention is made in the annual report and in a letter of thanks from the Secretary of State for Foreign Affairs of the services of the director, Mr. A. J. B. Wace, who was attached to the British Legation at Athens during the war while carrying on the school as a hostel for British officers in transit or on duty in Greece.

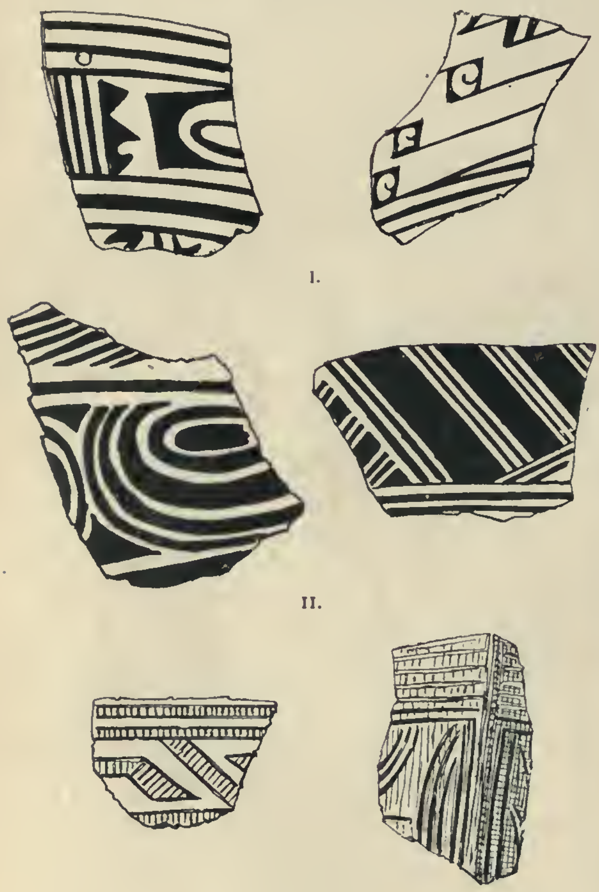

FIG. 1.—Specimens of prehistoric pottery from Dikilitash. I. Dimeni ware; fine reddish biscuit, surface usually bright chestnut; patterns, a mixture of geometrical and curvilinear figures in dull brown paint. II. Black or red biscuit; patterns, geometrical designs, parallel lines in sets of threes, and rows of concentric circles, in dull white paint. III. Coarse black or red biscuit; patterns, similar to those of I. and II. filled in with cross-hatching or painted; specimen on right is painted and incised. From "The Annual of the British School at Athens."

FIG. 2.—Wall of ruined fort near Kato Kastelli, in ancient Doris. From "The Annual of the British School at Athens."

The greater part of the volume is devoted to the publication, by Prof. E. A. Gardner, Messrs. Carson, Welch, Woodward, and others, of sites, inscriptions, and other antiquities discovered during the British occupation of Salonica. This district was previously very ill-explored, but numerous finds were made in trenching operations and military surveys. The contents of the museum formed at British G.H.Q. have now been presented by the Greek Government to the British

[1] "The Annual of the British School at Athens." No. xxiii. Session 1918–19. Pp. xvi+260+xvi pls. (London: Macmillan and Co., Ltd., n.d.) Price 30*s*. net.

nation, and are placed in the British Museum. The corresponding discoveries in the French zone of occupation, further west, are summarised by Capt. Ch. Picard, now director of the French Archæological School at Athens. The finds in both zones were of all periods. The most novel illustrate the earlier periods from the Neolithic to the early Iron age, revealing new distributions of pottery styles, and types of primitive figurines, and raising a number of questions which can only be solved by systematic excavation as soon as local conditions allow.

FIG. 3.—Ruins at Hagia Sophia in Lemnos. From "The Annual of the British School at Athens."

Mr. M. N. Tod publishes twenty-five Greek inscriptions from the same district, and Mr. A. M. Woodward adds a note on the Byzantine castle of Avret-Hissar (*Gynaikokastro*).

Other war surveys are published by Mr. F. W. G. Foat, who was in charge of "educational work on topography and archæology" at the Y.M.C.A. rest camps in ancient Doris, and on the island of Lemnos by Mr. F. L. W. Sealy, who appends also notes on birds and fishes observed there. Mention should also be made here of Mr. Hasluck's paper on "The Rise of Modern Smyrna."

Further afield, Mr. S. Casson, who was for a while in charge of the Salonica Museum, made good use of a flying visit to the Caucasus and Western Turkestan to describe an extensive series of prehistoric mounds, and to throw fresh light on Herodotus' account of the ancient routes eastward from Scythia.

Other papers, such as those on the fictitious legend of "Saint Gerasimos and the English Admiral" and on "The Folklore of a Turkish Labour Battalion," illustrate more special aspects of research under war conditions, and also the great variety of subjects which are studied by members of the British School at Athens.

The Annular Eclipse of April 8.

By DR. A. C. D. CROMMELIN.

THE occurrence of a central solar eclipse within the limits of the British Isles is a somewhat rare event. On the average, one total eclipse is visible here in seventy years, and one annular eclipse in about sixty years. It is, therefore, noteworthy that the decade now commencing supplies examples of both. There has been no British total solar eclipse since 1724, the interval being about three times the average; the last annular eclipse was in 1858. After the present decade there will be totalities in 1999 and 2090, and annularity in 2093.

The central line on April 8 passes across South Uist, just misses Cape Wrath, and then runs a few miles north-west of the Shetlands. The south limit of annularity enters Scotland near Ardnamurchan Point, and runs nearly parallel to the Caledonian Canal, emerging near Wick. Thus practically the whole of the counties of Ross and Cromarty, Sutherland and Caithness, and a corner of Inverness, together with the Outer Hebrides, Skye, and the Orkneys and Shetlands, will enjoy the annular phase.

The eclipse occurs about 9 a.m., the sun's altitude being about 23°; the duration of annularity is 111 sec., the width of the annulus of sunlight being 26″. This implies that 1/19 of the sun's disc will remain uncovered; in other words, the illumination will exceed normal sunshine on the planet Jupiter. Remembering what a resplendent object Jupiter appears in the night sky, it will be seen that there will be nothing approaching darkness. Venus will doubtless be readily visible, about 20° east of the sun; it will be a slender crescent, inferior conjunction occurring a fortnight later. The only other object that may possibly be visible is Vega, which will be high in the west, three hours past the meridian.

Dr. J. K. Fotheringham, who has made a special study of the records of ancient eclipses, intends to examine the question of its visibility, as it is important to know what degree of solar obscuration is implied by the frequently recurring phrase, "Stars were visible." It is used, for example, by Thucydides with reference to an eclipse which was not total anywhere.

As regards useful observations that may be made in the coming eclipse, the exact times of the beginning and end of annularity can be accurately noted, especially by the method of projection upon a white screen; they serve to correct the position of the moon; those who cannot determine absolute time can still do good work by timing the exact duration of annularity; this applies especially to observers fairly near the limit of annularity. Prof. Newcomb found numerous records of this kind, made in England during the total eclipse of 1715, which enabled him to correct Hansen's value of the centennial motion of the moon's node. Photographs taken about mid-eclipse, on as large a scale as possible, would be of value for determining the difference of the diameters and ellipticities of sun and moon.

Useful spectroscopic work can also be done, the diminution of sky-glare being of service in photographing the prominences or reversing layer. The British Astronomical Association, which has experience of a great number of eclipses, is prepared to organise work if a sufficient number of observers send in their names.

It is possible to reach observing stations by rail, either on the line to Wick and Thurso, or on that running westward from Dingwall to Loch Alsh (for Skye); the journey from London to the eclipse zone is in the neighbourhood of twenty-two hours, and the return fare (third class) in the neighbourhood of 8*l.* at present rates. The season is probably too early for the steamboat services, otherwise these would afford a ready means of reaching observing stations on the mainland or islands.

Besides astronomical work, the eclipse affords opportunities for at least three other studies: (1) Meteorological. The temperature is directly affected, and there are frequent indirect effects on barometer, wind, and cloud formation. (2) Magnetical. The work of the Carnegie Institution of Washington, under Prof. L. Bauer, has established a connection between eclipses and the elements of terrestrial magnetism. Such a connection is in no way surprising, for the diurnal variation in these elements has long been known, so it is to be expected that the interposition of the moon should act similarly to the interposition of the earth during the night hours. (3) Wireless telegraphy. A notable improvement in the clearness of signals has been observed during eclipses, which is again analogous to what happens during the hours of darkness. Advantage might be taken of this to make time comparisons for longitude about the time of greatest eclipse. The eclipse is large enough for this purpose throughout the British Isles. The magnitude at Edinburgh is 0·95; Dublin, 0·94; Oxford and Cambridge, 0·89; and Greenwich, 0·88.

FIG. 1.—Track of the annular eclipse of April 8, 1921.

There will be a total solar eclipse in England and Wales on June 29, 1927 (civil). The central line will run from near St. David's Head to near Whitby, where the sun will have risen about $1\frac{3}{4}$ hours, and totality will last 24 sec. At the total eclipse of January 24, 1925, the track of totality will graze the Western Hebrides, but with a very low sun. It will be necessary to go to the neighbourhood of New York for effective observations on that occasion.

Obituary.

PROF. EMILE BOURQUELOT.

BY the death of Emile Bourquelot, Professor of galenical pharmacy in the University of Paris, science has sustained an irreparable loss. Born in a small village in the Ardennes in 1852, Bourquelot was apprenticed in a pharmacy in Sedan while the town was still occupied by the Germans. He afterwards became chief pharmacist in the Hôpital Laeonec, and then successively assistant professor and professor of galenical pharmacy in the Ecole Supérieure de Pharmacie, now the faculty of pharmacy in the University of Paris. Bourquelot at once devoted himself to the investigation of various pharmaceutical problems, but gradually restricted himself almost entirely to the study of the enzymes occurring in drugs and various plants, their action and the changes brought about by them in the constituents of drugs and their galenical preparations. His researches in this direction, often in conjunction with M. Hérissey, M. Bridel, and other of his assistants and pupils, gained for him a world-wide reputation. His investigation of the constituents of gentian root and of the changes brought about by enzymes during the drying of the root and the making and keeping of preparations made from it may well serve as a model for future workers. The latter years of his life were mainly devoted to the study of the synthetical as well as the analytical action of enzymes, in which field remarkable results were obtained.

To his scientific attainments Bourquelot added a personal charm that fascinated everyone brought into contact with him. His unfailing courtesy and friendly disposition endeared him to all. He was one of the most eloquent of lecturers, and those who were fortunate enough to hear his lecture on "The Synthesis of Glucosides by Ferments" at the International Congress of Pharmacy at The Hague in 1913 will long remember his admirable lucidity, clear enunciation, and exquisite delivery.

Though Bourquelot had been in indifferent health for the last two or three years the end came with dramatic rapidity, and pharmacy was robbed of one of its most brilliant exponents.

COL. R. A. WAUHOPE.

COL. R. A. WAUHOPE, whose death is announced, was, perhaps, better known for the splendid quality of his practical work at map-making on the Indian frontier (and beyond it) than for researches into those branches of geodetic science which form the special objective of that section of the Indian Survey Department which is centred in Dehra Dun. He was one of the first and best of those surveyors who reformed the antiquated methods of geographical reconnaissance and proved that sound square mapping may be evolved on precisely the same principles of triangulation and topography in the field of an expedition or a campaign as govern the output of Ordnance mapping in the quiet fields of home survey.

Col. Wauhope's science consisted in the clever combination of exact methods, where they were possible, with the scientific adaptation of inexact methods (that is to say, methods not ordinarily recognised as permissible under normal conditions of map-making), and obtaining therefrom results which have proved to be satisfactory. The best instance of such adaptation was afforded when he fixed the initial point of the Russo-Afghan boundary at the head of Lake Victoria, in the Pamirs, by the method of instrumental resection from distant Himalayan peaks (the position of which had been determined by a regular geodetic series of the Indian triangulation) in circumstances where direct intersection from a regular series across the Himalayas was impossible. Such a direct series was eventually carried through with much difficulty and at great expense of money and time from India to the same point, when it was found in the first place that the result in absolute values of latitude and longitude was almost coincident with Wauhope's value, and, in the second, that it was doubtful whether the result of direct triangulation completed under abnormal conditions was the more trustworthy of the two. In this special case it must be remarked that few surveyors possess that physical capacity which enabled Col. Wauhope to attain the elevations necessary for observation.

T. H. H.

MR. GEORGE CLINCH, the librarian of the Society of Antiquaries, whose death, on February 2, we regret to record, joined the staff of the society in January, 1896, having previously been employed at the British Museum. In May, 1886, he exhibited to the society a collection of flint implements found by him during eight years in West Wickham, Kent. In December, 1888, Mr. Clinch reported to the society the results of excavations made by him during the ten previous years in the supposed pit-dwelling at Hayes Common, in the same county. Later, he published a volume entitled "Antiquarian Jottings," describing in a popular manner these and other researches in the same district. Mr. Clinch also wrote a number of the "Little Guides," and a work on old English churches. He prepared the annual Lists of Archæological Papers after they had been discontinued by Sir Laurence Gomme. As librarian he earned the esteem of the fellows and others using the library by his courtesy and readiness to assist. He was in his sixty-first year.

THE death is announced, in his sixty-sixth year, of DR. WILLIAM THOMPSON SEDGWICK, who had been connected with the Massachusetts Institute of Technology since 1883 as successively assistant professor, associate professor, and full professor of biology. He had also been, since 1897, curator of the Lowell Institute, Boston, and since 1902 a member of the advisory board of the hygienic laboratory of the U.S. Public Health Service. Prof. Sedgwick was author of "Principles of Sanitary Science and Public Health," and joint author of "General Biology," "The Human Mechanism," and "A Short History of Science."

WE much regret to announce the death, on February 17, at ninety-one years of age, of DR. W. ODLING, F.R.S., Waynflete professor of chemistry at the University of Oxford from 1872 to 1912; also on February 21, at seventy-eight years of age, of PROF. L. C. MIALL, F.R.S., Emeritus professor of biology at the University of Leeds; and on February 22, in his eighty-fifth year, of PROF. R. B. CLIFTON, F.R.S., lately professor of experimental philosophy in the University of Oxford.

THE death is announced, on February 16, in his seventy-ninth year, of MR. C. GROVER, for many years astronomical assistant at Sir C. E. Peek's observatory at Rousdon, Devon.

Notes.

LORD MOULTON has been elected an honorary member of the Institution of Civil Engineers.

AT the meeting of the Royal Society on May 12 a discussion on "The Quantum Theory of Line-Spectra" will be opened by Sir Ernest Rutherford, followed by Dr. N. Bohr.

THE thirtieth annual meeting of the Royal Society for the Protection of Birds will be held at the Middlesex Guildhall, Westminster, S.W., on Tuesday, March 8, at 3 p.m. The Right Hon. Field-Marshal Lord Methuen, vice-president of the society, will occupy the chair.

PROF. C. S. SHERRINGTON, president of the Royal Society, has been elected a member of the Athenæum under the provisions of the rule of the club which empowers the annual election by the committee of a certain number of persons "of distinguished eminence in science, literature, the arts, or for public service."

THE council of the Royal Statistical Society will in November next award the Frances Wood memorial prize, value 30*l*., for the best investigation of any problem dealing with the economic or social conditions of the wage-earning classes. Particulars may be obtained from the honorary secretaries of the Royal Statistical Society, 9 Adelphi Terrace, W.C.2.

THE twenty-fifth anniversary of the discovery of the "Zeeman effect" will take place on October 31 next. A committee has been formed by scientific men in Holland to mark the occasion by showing their appreciation of the importance of the discovery and of the distinguished services which Prof. Zeeman has rendered to science. It is intended to raise a fund to be placed at his disposal for researches to be conducted in the physical laboratory of the University of Amsterdam. Any contributions to this fund may be sent to Sir Arthur Schuster, Yeldall, Twyford, Berkshire, who will forward them to the Dutch committee.

THE annual general meeting of the Institute of Metals will be held in the room of the Institution of Mechanical Engineers on Wednesday and Thursday, March 9 and 10. A paper on the recrystallisation of aluminium sheet by Prof. H. C. H. Carpenter and Constance F. Elam, and another on calcium by Mr. P. H. Brace, will be presented at the morning session on March 9. The afternoon session of the same day and the morning session of March 10 will be devoted to four papers on copper and copper alloys by Prof. C. A. Edwards and Mr. A. M. Herbert, Mr. H. Moore and Mr. S. Beckinsale, Mr. H. Moore, Mr. S. Beckinsale and Mr C. E. Mallinson, and Dr. J. L. Haughton. The afternoon session of March 10 will take the form of a visit to the National Physics Laboratory. The annual dinner of the society will be held on the evening of March 9

SIR FRANCIS YOUNGHUSBAND, president of the Royal Geographical Society, announced to the society on Monday that since the previous meeting of the Mount Everest Committee further progress had been made with the organisation of the expedition. Subject to the approval of the Government of India, Major Morshead and Capt. Wheeler will accompany the expedition as survey officers. Dr. Kellas, who has for many years devoted himself to Himalayan exploration, has accepted an invitation to join the expedition, and also Mr. G. L. Mallory and Capt. George Finch. Sir Francis Younghusband added:—"Our party for the reconnaissance is thus complete, and we are now engaged in equipping it in the best possible manner for the important work it will have to do this summer in examining the mountain from every angle and testing the possible ways by which its summit may be reached."

AT the annual general meeting of the Association of Economic Biologists, held in the Imperial College of Science on Friday last, the following were elected officers and councillors for the year 1921:—*President:* Sir David Prain. *Hon. Treasurer:* Dr. A. D. Imms. *Hon. Secretary* (*Gen. and Bot.*) Wm. B. Brierley. *Hon. Secretary:* (*Zool.*): Dr. S. A. Neave. *Hon. Editor* (*Bot.*): Wm. B. Brierley. *Hon. Editor* (*Zool.*): D. Ward Cutler. *Council:* Dr. W. Lawrence Balls, Prof. V. H. Blackman, F. T. Brooks, A. B. Bruce, Dr. E. J. Butler, F. J. Chittenden, A. D. Cotton, J. C. F. Fryer, Prof. J. B. Farmer, E. E. Green, Dr. G. A. K. Marshall, and Dr. E. J. Russell. In view of the very great increase in the publishing costs of the *Annals of Applied Biology*, it was decided to establish a "Publication Fund," to which all interested in the progress of biology and in its application to the welfare of man are invited to subscribe. Sir David Prain then delivered his presidential address on "Some Relationships of Economic Biology."

AT the annual general meeting of the Physical Society held on February 11, the following officers were elected:—*President:* Sir W. H. Bragg. *Vice-Presidents who have filled the office of President:* Dr. C. Chree, Prof. H. L. Callendar, Prof. R. B. Clifton, Sir Richard Glazebrook, Sir Oliver J. Lodge, Prof. C. H. Lees, Prof. A. W. Reinold, Sir Arthur Schuster, Sir J. J. Thomson, and Prof. C. V. Boys. *Vice-Presidents:* Prof. W. Eccles, Prof. A. S. Eddington, the Right Hon. Lord Rayleigh, and Prof. Sir Ernest Rutherford. *Secretaries:* Mr. F. E. Smith, National Physical Laboratory, Teddington, and Dr. D. Owen, 62 Wellington Road, Bush Hill Park, N. *Foreign Secretary:* Sir Arthur Schuster. *Treasurer:* Mr. W. R. Cooper, 82 Victoria Street, S.W.1. *Librarian:* Prof. A. O. Rankine. *Other Members of Council:* Dr. G. B. Bryan, Mr. C. R. Darling, Prof. C. L. Fortescue, Dr. E. Griffiths, Dr. F. L. Hopwood, Dr. E. H. Rayner, Dr. A. Russell, Mr. T. Smith, Dr. J. H. Vincent, and Prof. W. B. Morton.

REPORTS have appeared in the daily Press respecting a serum treatment for tuberculosis introduced by M. Henri Spahlinger, of Geneva, shortly before the outbreak of war. Preliminary trials of the serum have been made upon a small number of selected cases by physicians in London and Paris, and it is stated that cases treated in 1913 are still alive and well. The nature and mode of preparation of the remedy do not appear to be disclosed, but according to a communication made by Prof. D'Arsonval to the Paris Academy of Sciences, M. Spahlinger divides tuberculosis cases into two classes for purposes of treatment, (1) acute cases treated by means of "complex antitoxic and bacteriolytic serums" and (2) chronic cases treated by "vaccination with a series of antigens and ferments," the former being derived from the bacillary substance of the tubercle bacillus. Patients are finally treated with a series of injections of the different antigens given separately. The preliminary trials have apparently been so successful that a tuberculosis specialist is being sent by the Ministry of Health to Geneva to investigate at first hand the Spahlinger cure.

CONSIDERABLE concern has been expressed at the announcement that the Treasury contemplates the withdrawal of grants hitherto given to the Industrial Fatigue Research Board, and at the recent conference on this subject at Olympia a resolution was carried urging the Government to revoke this decision. It appears that the withdrawal of the grant is regarded as a measure of economy, but anyone conversant with industrial matters is aware of the great waste occasioned by unnecessary fatigue, both in slowing down the speed of production and in leading to accidents and ill-health. Rightly regarded, therefore, researches having for their object the elimination of such fatigue are essentially "economical." The work of the Board has hitherto been conducted on a modest scale, and its expenditure has been small in comparison with the importance of its field of operations. Other countries, we believe, have followed our lead in instituting such inquiries, and their discontinuance would be most regrettable. It is also to be feared that the step proposed in regard to the Industrial Fatigue Research Board will constitute a regrettable precedent by discouraging investigators from taking up work of this nature, and that it may be followed by the restriction or withdrawal of facilities for research in other directions. We sincerely hope that the efforts being made to induce the Treasury to revoke the decision will be successful.

IN accordance with the provisions of the Dyestuffs (Import Regulation) Act, 1920, the President of the Board of Trade has appointed the following Committee to advise the Board of Trade with respect to the granting of licences under the Act:—Mr. V. Clay (joint managing director, Robert Clay, Ltd.), Mr. G. W. Currie, Mr. G. Douglas (managing director, Bradford Dyers' Association, Ltd.), Mr. E. V. Evans (treasurer of the Society of Chemical Industry), Dr. M. O. Forster (director of the Salter Institute of Industrial Chemistry), Mr. C. C. Railton (director, Calico Printers' Association, Ltd.), Mr. H. B. Shackleton (Messrs. Taylor, Shackleton and Co., Shipley), Mr. T. Taylor (Cornbrook Chemical Co., Stockport), Mr. S. A. H. Whetmore (British Dyestuffs Corporation, Ltd.), and Mr. W. J. U. Woolcock (general manager, Association of British Chemical Manufacturers). Pending the appointment of a permanent chairman, which it is hoped to make at an early date, Mr. Percy Ashley, assistant secretary, Industries and Manufactures Department, Board of Trade, will act as chairman of the Committee. The secretary to the Committee is Mr. W. Graham, and all applications for licences should be addressed to the Secretary, Dyestuffs Advisory Licensing Committee, Danlee Buildings, Spring Gardens, Manchester.

THE Lord President of the Council has established an Inter-Departmental Committee on Patents with the following terms of reference:—(1) To consider the methods of dealing with inventions made by workers aided or maintained from public funds, whether such workers be engaged (*a*) as research workers or (*b*) in some other technical capacity, so as to give a fair reward to the inventor and thus encourage further effort, to secure the utilisation in industry of suitable inventions, and to protect the national interest; and (2) to outline a course of procedure in respect of inventions arising out of State-aided or supported work which shall further these aims and be suitable for adoption by all Government Departments concerned. As at present constituted, the Committee consists of the following members:—Dr. Kenneth Lee (chairman), Mr. W. St. D. Jenkins, Mr. F. E. Smith, Sir E. L. Ellington, Mr. H. W. W. McAnally, Mr. P. W. L. Ashley, Col. W. H. D. Clark, Sir H. Frank Heath, Mr. A. J. Stubbs, Dr. H. H. Dale, Mr. W. J. Coombes, Lt.-Col. P. K. Lewes, Mr. P. Tindal Robertson, Sir Richard Gregory, Mr. D. M. Kerly, and Sir Charles A. Parsons. The secretary to the committee is Mr. A. Abbott, to whom all communications should be addressed at 16 and 18 Old Queen Street, Westminster, London, S.W.1.

MR. F. H. CARR, in a paper on the post-graduate training of chemical students for industry read at a meeting of the Old Students' Association of the Royal College of Science on February 8, outlined a scheme involving the establishment of a technological teaching laboratory which would, in practice, be a miniature manufacturing concern, attached to a college, providing the necessary lectures and class-room instruction. The plant would be available for technical-scale experiments interpreting the results of research work from research institutions or elsewhere. Further, it would be utilised for the manufacture of those fine chemicals that are not ordinarily obtainable in the chemical trade, and of which a restricted and irregular supply is required by colleges and research laboratories. This manufacturing laboratory would be conducted under conditions of strict and complete business organisation and discipline. A fundamental object of the instruction suggested would be the introduction of the cost factor in relation to power, heat, labour, material, and yield, whilst a spirit of reality would be maintained by disposing of the products so far as possible through existing trade channels. The nature of the work, as exemplified in the syllabus, would be general, and would not be identified with any particular branch of industry; it would keep in view the necessity for a training in the broad principles underlying chemical technology. If possible, arrangements would be made for the students to attend manufacturing works for courses of practical instruction, and special teaching would be provided by men actually engaged in the various specific chemical industries. An interesting feature of the discussion which followed Mr. Carr's paper was the united praise bestowed upon Prof. J. F. Thorpe's scheme—now approaching completion—of a technical-scale laboratory to be established as an adjunct to the Honours Organic Laboratory at South Kensington.

In the January issue of *Man* Mr. T. A. Joyce describes a carved wooden coffer from British Columbia which has been recently acquired by the British Museum. It is a fine specimen of native work, the central panel on one side representing a grizzly bear protecting its cub. The eyes, ears, nostrils, and fore-paws of the bear are inlaid with abalone (haliotis) shell, while the mouth of the larger figure is furnished with twelve graduated deer-teeth. Coffers of this kind were used by men of rank for storing valuable property, such as the hereditary insignia worn by individuals who had the right of impersonating certain legendary and supernatural beings at the winter ceremonials. The British Museum is indebted for the coffer to Mr. St. George Littledale, who obtained it and generously presented it to the nation.

Some time ago the Library Association instituted examinations in librarianship and granted certificates on the result. From the report of a discussion opened by Dr. W. E. Hoyle, and printed in the *Museums Journal* for February, it appears that the Museums Association contemplates similar action. Taking as a *sine qua non* a high standard of general education, the next essential is a good grounding in the particular branch of knowledge appropriate to the candidate's proposed work. Lastly follows a special training in museum administration and methods. Clearly it is in this last that the difficulty lies, both for training and for examining. Perhaps the most practical suggestion made in the discussion was that an apprenticeship should be served in the national museums. To some extent, by force of circumstances, that has been the case in the past, but it was not an accepted or organised method. Whether a man is to stay in the central museum or whether he is to take a post in the provinces, it is most desirable that he should pass through the mill and learn his business in the administrative and technical departments from the bottom upwards.

The first part of vol. lxv. of the *Quarterly Journal of Microscopical Science* marks a new era in the history of that well-known periodical. Prof. E. S. Goodrich has succeeded Sir Ray Lankester as editor-in-chief, and at the same time the publication has passed from the hands of Messrs. J. and A. Churchill into those of the Oxford University Press. Unfortunately, these changes are accompanied by a rise in price from 12*s*. 6*d*. to 1*l*. 1*s*. per number. We hope that this increase will not be counterbalanced by a corresponding decrease in the number of subscribers.

The current issue of the *Quarterly Journal of Microscopical Science* (vol. lxv., part 1) contains a rather startling paper by Mr. Arthur Bolles Lee on "The Structure of Certain Chromosomes and the Mechanism of their Division." After describing the animal chromosome as consisting normally of an axial core of basophilous chromatin twisted into a screw-like form with a spiral flange, and an investing sheath with acidophilous staining properties, he proceeds to deny that the longitudinal splitting of chromosomes which has formed the basis of so much theorising really takes place. According to Mr. Lee's view, the double character so suggestive of longitudinal splitting arises from the close approximation of the limbs of an originally **V**-shaped chromosome, and the division of the chromosome really takes place by rupture at the apex of the **V**. It will be interesting to see what other cytologists have to say about this iconoclastic statement.

We have received a copy of a special issue of *Die Naturwissenschaften* commemorating the twenty-fifth anniversary of the discovery of X-rays by Prof. Röntgen. A portrait of the discoverer forms the frontispiece, but is a rather disappointing reproduction. Original articles are the attraction, and are written by men well known in their respective spheres. Four out of the eight articles are devoted to the part which can be played by X-rays in the determination of atomic structure in crystals and other substances. The technical developments in the manufacture of X-ray tubes are described by Knipping in a brief article, the medical uses of X-rays being dealt with by Levy-Dorn. Radiographic reproductions receive scant justice, owing to the poor quality of the paper used. The issue concludes with a long article by Pfeiffer on the vital part which X-rays have played in many problems in chemistry.

In the November, 1920, issue of the *Journal de Physique et le Radium*, M. A. Dufour describes his cathodic oscillograph, which gives a photographic reproduction of any phenomenon which can be translated into a constant or variable magnetic or electric field so long as the frequency involved does not exceed 10^9 per second. The cathode rays utilised are produced at a plane cathode at the top of a vertical tube and are fired down through a pierced anode into a bell-shaped metal chamber, at the bottom of which a fluorescent screen or a cylindrical photographic film can be placed. The chamber can be exhausted, and provision is made for magnetic control from outside of the motor which rotates the cylinder. The electric or magnetic field is applied to the rays at the top of the bell chamber, and for low frequencies the cathode rays are moved parallel to the axis of the cylinder, which itself rotates at a uniform rate. For high frequencies the photographic film remains at rest while an auxiliary oscillation of low frequency but large amplitude at right angles to that to be studied is imparted to the rays. In order to prevent overlapping of the curves, a further slow motion of the ray parallel to the original motion is introduced by the slow change of a second auxiliary magnetic field.

WE learn from the *British Journal of Photography* for February 11 that at the meeting of the Royal Photographic Society held on February 9, Mr. Thorne Baker and Dr. L. A. Levy introduced "a new X-ray plate reducing exposure to one-twenty-fifth," and indicated its special application to radio-metallurgy. The plate is distinguished as the Imperial "Impex." Its extraordinary sensitiveness is obtained by incorporating the intensifying screen with the plate. The screen consists of a layer of calcium tungstate in soluble gelatine, and is coated on top of the emulsion which is hardened, so that after the exposure the screen can be dissolved off by water at 100° F. and development then carried out as usual. The screen being in optical contact with the emulsion, an "infinitely smaller" quantity of calcium tungstate is necessary to give the required intensification. The new plate takes a little longer to develop than usual (say 25 per cent.). The size of the particles of the calcium tungstate is some two or three times that of the particles of silver salt in the emulsion.

THE hope has often been expressed that means might be found for desensitising a photographic plate after its exposure, so that its development might be done without the extreme precautions that are necessary as to the light employed. This applies with the greatest force to highly sensitive panchromatic plates, which stand so very feeble a light that most persons prefer none at all, trusting to the time of treatment that is supposed to be suitable to the temperature of the developer. It has been found that certain substances possess the desired effect to a greater or less degree, but for one reason or another they have not proved acceptable. But "desensitol," which has just been put upon the market by Messrs. Ilford, Ltd., is simple to use and very effective. It is a solution of a red dye, and it is only necessary to dilute it with 50 parts of water and immerse the exposed plate in it, then after one minute the light may be increased to from 200 to 800 times the brightness that would previously have been safe, and the plate transferred to the developer and watched in comfort. From a scientific point of view there are many interesting points about such desensitising action, and we hope that we shall soon see the results of investigations into the changes, if any, produced by the desensitiser in the form of the characteristic curve and the proportional colour sensitiveness of plates of various kinds.

THERE can be very few officers who served in France who are not familiar with the co-ordinate reference card which was issued by the War Office to facilitate map descriptions and map measurements after the introduction of the application of a cartesian grid to all Service maps up to scales of 1 : 40,000. The same idea is embodied in the "Romer graph plotter" (A. G. Thornton, Ltd., Paragon Works, 49 King Street West, Manchester). A rectangular piece of cardboard (or celluloid), 8″×6″, is graduated along its edges with the zero graduations at the top right-hand and the bottom left-hand corners. By this means, given two rectangular axes, a point of given co-ordinates can be plotted and the co-ordinates of a given point read off without the use of squared paper and as accurately as would be possible if squared paper were employed. The advantages are obvious. Accurate graphs can be drawn in ordinary note-books or on ordinary paper; the attention of the student is concentrated on the graph rather than on the axes; and, more important still, the expense involved in the purchase of squared paper, by no means a small item, is avoided. Teachers of mathematics and science will probably not regret giving this instrument a trial.

A KINEMATOGRAPH projector of a new type was demonstrated by Mr. R. J. Trump at the Imperial College, South Kensington, on February 10. The invention of Mrs. Kingsley-Higginson, it employs, in place of the shutter and intermittent film-feeding gear of the ordinary machine, a continuously rotating ring of mirrors to stabilise the image and effect the change of picture while the film is run uniformly through the machine. The beam of light is thus always passing unobstructed to the screen, and the alternations of light and darkness produced by the shutter, which constitute the flicker of the ordinary projector, are avoided. The new apparatus can be run quite slowly if required, and in any case there is no necessity to speed it up in the way that is at present usual. The change of picture takes place zone by zone across the screen, which always shows a full image, derived from parts of two successive pictures on the film. The facets on the ring of mirrors are so arranged and set at such an angle that the two lights from the two partial film-pictures which are present at any instant in the gate are separated and transposed into their correct positions on the screen, and join up to form a complete image. There is no dark period and no overlapping or dissolving of the successive pictures into each other, as the first picture disappears at precisely the same rate that the second takes its place. A good and sharply defined image is obtained. The advantages of a uniform feed for the film are considerable, in that the wear and tear upon it are much reduced and the risk of breakage is negligible. The application of the same principles to kinemaphotography is under consideration, and there is every expectation that useful results will be obtained.

MESSRS. SOTHEBY, WILKINSON AND HODGE will sell by auction at their galleries at 34 and 35 New Bond Street, W.1, on Thursday and Friday, March 3 and 4, a large number (509 lots) of valuable works dealing with natural history and travel, the property of the late Dr. F. du Cane Godman. Many rare books are included, also several long runs of scientific journals and transactions of learned societies. The catalogue should be of great interest to many readers of NATURE.

SIR WILLIAM TILDEN has written for publication by Messrs. George Routledge and Sons, Ltd., a book on "Famous Chemists: The Men and their Work," in which the lives of twenty-one leading chemists, from Robert Boyle to Sir William Ramsay, will be dealt with in a non-technical manner. The sketches, while chiefly biographical in character, will give attention to the social and political conditions of the times in which the subjects dealt with lived, in order to show the relation of discovery in physical science to the progress of civilisation.

A SOMEWHAT novel way of keeping a book up to date, other than by issuing new editions, has been devised by the Cambridge University Press, which has projected a series of monographs intended to serve as supplements to Dr. Norman R. Campbell's "Modern Electrical Theory." The series will be edited by Dr. Campbell, who, however, will not write all the volumes. The first three monographs will deal with spectra, the quantum theory, and the constitution of atoms and molecules. It is proposed that the series shall correspond roughly with the chapters of the original book, and eventually supersede the latter.

ANNOUNCEMENT is made of the amalgamation of the firms of Messrs. John Wheldon and Co., of 38 Great Queen Street, Kingsway, W.C.2, and Messrs. William Wesley and Son, of 28 Essex Street, Strand, W.C.2. Both firms are well known in the world of science as booksellers and publishers of repute. The business of John Wheldon was established in 1844, and was concerned mainly with supplying collectors and institutions with scientific works; recently it has developed in the direction of economic and applied natural science. Of particular value to the new firm will be the collection of scientific journals held by John Wheldon and Co. The business of William Wesley and Son was established in 1855, and dealt similarly with books and journals of science. A valuable side of the firm's activities, which will be continued by the new company, is the numerous agencies which are held for the sale of publications of foreign and Colonial Governments and societies. The establishments will be carried on in future in the name of Messrs. Wheldon and Wesley, Ltd., under the guidance of Mr. H. K. Swann and Mr. E. F. Wesley, who have been managers and proprietors of their respective firms for a number of years.

Our Astronomical Column.

A STUDY OF THE STARS OF TYPE N.—The stars of type N (Secchi's fourth type) are of great interest; they were formerly supposed to be near the end of their career as suns. However, their concentration in the galaxy is a proof of great distance, and shows that they are in the giant stage. Lick Observatory Bulletin No. 329 contains a photographic study of the spectra of two bright stars of the class, 152 Schjellerup and 19 Piscium, by C. D. Shand. Lines in these spectra are very numerous, which increases the difficulty of identification. The presence of carbon, hydrogen, iron, titanium, vanadium, chromium, sodium, manganese, calcium, scandium, and yttrium is certain; four other elements are suspected. It is difficult to decide whether apparent bright lines are really emission lines or mere spaces between absorption lines; the author inclines to the former view.

The most striking feature of the spectra is the "Swan" carbon spectrum; the cyanogen bands are also prominent, and possibly carbon monoxide is indicated. The suggestion is made that the oxygen present may all combine with carbon, thus explaining the absence of titanium oxide, which is prominent in the M stars.

Many of the N stars are variable, resembling in this point the Md stars. It was formerly suggested that the variability of these faint red stars is due to incipient crust formation, which caused accumulation of heat within, leading after a time to the melting of the obstruction. However, the discovery that these stars belong to the giant class renders the crust theory unlikely. Dr. Merrill recently suggested an alternative; he postulates a veil of blue smoke above the photospheres of these stars, producing almost complete absorption of the shorter waves, and also to some extent obstructing the longer heat-rays. An accumulation of heat results which may suffice to vaporise the occulting clouds of carbon, so that a temporary increase of light occurs.

Spectral changes at various stages of the cycle are discussed. The bright hydrogen lines are most intense at maximum and practically absent at minimum, at which time the carbon absorption becomes stronger. These changes are closely analogous to those in the Md stars.

THE MADRID OBSERVATORY.—The Anuario of the Madrid Observatory, 1921, in addition to the usual tabular astronomical data, contains full details of sun-spots and prominences during 1919, with diagrams of remarkable prominences, including the great May one seen during the total eclipse. There is also an article on the spectrum of Nova Cygni 1920 by P. Carrasco. Spectra, photographed at Madrid on nineteen days between August 23 and September 29, are reproduced in a manner making it easy to trace the progressive changes. There is a full table of wave-lengths of lines, with probable origin, and comparison with the spectra of α Cygni and β Orionis. The earliest spectra (August 23–24) are almost purely absorption spectra. The bright bands are traceable on August 25 and conspicuous from August 27 onwards. The volume also contains the meteorological observations made at Madrid Observatory in 1919.

POPULAR ASTRONOMY IN SWEDEN.—*Populär Astronomisk Tidskrift* is an attractive and well-illustrated periodical the publication of which was commenced last year by the Swedish Astronomical Society under the editorship of S. Arrhenius, K. Bohlin, N. V. E. Nordenmark, and H. von Zeipel. The articles in Häfte 3–4 deal with Nova Aquilæ, the moving cluster of the Hyades (for which a parallax of 0·027″ is found), and Dr. Harlow Shapley's work on the globular clusters. Mr. Nils Tamm contributes an illustrated article on the Kvistaberg Observatory; the work during 1920 included studies of Mars, Jupiter, Saturn, nebular photography, and magnitude determinations of Nova Cygni. Mr. Gyllensköld reproduces several pictures of auroral streamers, including some interesting photographs obtained at Bossekop, Lapland, in 1910. Some artificial auroræ obtained by Birkeland by cathode rays are illustrated, and the forms deduced from his theory are discussed and shown to agree very closely with the streamers of the solar corona in the eclipse of 1901.

Scientific and Technical Workers in the United States Civil Service.

By MAJOR A. G. CHURCH.

THE work of our Civil Service National Council in producing a scheme for reconstruction dealing with the clerical and manipulative workers in British Government Departments has its counterpart in that of a Congressional Joint Commission appointed by the United States Senate to investigate the remuneration and conditions of employment and the need for reform in the Civil Service of the Republic. The Joint Commission commenced its inquiry in March, 1919, and completed its report on reclassification and readjustment of compensation in March last. The report has now been published, and provides an interesting and illuminating commentary on the conditions which prevailed in the American Service before the war, the bewildering and chaotic multiplication of class within class, the gross anomalies in salaries, the absence of any just and sane retirement scheme, and the accentuation of this unsatisfactory state of affairs by war conditions. In this respect Washington appears to have suffered far more than London by the introduction of the "business man" element into its administrative service.

The findings of the United States Commission are particularly interesting in those sections devoted to the scientific, technical, and professional classes—classes, incidentally, which are not yet being considered as a whole by our own National Council. While recognising that the Government Service possesses distinct advantages for these classes, it considers that the advantages are offset to some extent by certain personal restrictions generally unknown in the academic and business world. It finds that "there is serious discontent, accompanied by an excessive turnover and loss, among its best-trained and most efficient employees," and that "the National Service has become unattractive to a desirable type of technical employee." It emphasises the melancholy fact that the advance in the rate of turnover among the scientific technical employees has been three times as fast as the advance for clerical employees; for the former class the average advance in salary on leaving the Government Service was 53 per cent. The resignation curve at the Patent Office is still going up so rapidly that this Department has almost ceased functioning.

To remedy this alarming state of affairs the Commission urges that every effort should be made to stimulate initiative and originality on the part of scientific and other professional workers. "It is peculiarly appropriate that the Federal Government should take the lead in research work of all kinds, but it cannot do so unless it is able to attract and retain independent thinkers of the highest type. The reduction of red tape to a minimum, the encouragement of freedom of thought and action to a maximum, and the direction of research by thoroughly trained investigators would all assist to make this possible." This passage might with equal justice and appositeness have been written as a commentary on the position of scientific workers in our own Government Departments.

For scientific and technical staffs under the reclassification scheme the following titles of classes have been adopted:—Junior, Assistant, Associate, Full Rank (indicated by the absence of any adjective), and Senior. The following table gives the salaries recommended for the various grades in dollars and £ sterling (calculated on an exchange value of £1 = 3·5 dollars). The rates of pay for skilled mechanics and unskilled labourers in the service of the State are also given for purposes of comparison:

Scientific and Technical Workers.

	Minimum	Increment	Maximum
Junior	$1800 £515	$120 £34	$2160 £617
Assistant	$2400 £687	$120 £34	$3000 £857
Associate	$3240 £926	$120 £34	$3840 £1096
Full Rank (physicist, chemist, civil engineer, etc.) ...	$4140 £1185	$180 £52	$5040 £1445
Senior	No fixed scale		
Skilled mechanic ...			$2100 £600
Unskilled labourer ...			$1140 £326

In addition to the above, it is recommended that the cost-of-living factor should be taken into account in determining salary scales.

For the senior-class administrative, scientific, technical, and other professional workers no fixed scales of salary are recommended. It is considered that "the incumbents of these one man or woman positions are the real leaders of the Civil Service of the Republic," and rigid salary scales might prevent their entrance or retention in the Service. The scales quoted apply to all scientific and technical workers employed by the State except medical officers, whose initial salaries are lower and increments larger, but whose final salaries are also lower than those quoted above. The qualification for appointment as a junior scientific or technical worker is apparently the same as that laid down for similar appointments under the Government of this country.

It is laid down as a principle that there should be no discrimination on account of sex; men and women should receive equal pay for equal work, and the door of promotion should be opened impartially to members of both sexes.

Among other noteworthy recommendations by this Commission are the following:

(1) The appointment of an Advisory Council of twelve members to the Civil Service Commission: six to be nominated by the President of the United States and six to be elected by the employees.

(2) The adoption of an efficiency rating system to govern promotions, demotions, and increments.

(3) Interdepartmental promotions.

(4) Upon appointment to a position in a particular class an employee should be paid at the minimum rate prescribed for such class.

(5) Annual leave to be uniform throughout all classes of employees, viz. 2½ days per month.

(6) Investigation as to the possibility of the adaptation of psychological tests to the selection of candidates for the Civil Service.

It is improbable that the last two recommendations would be likely to find much favour in the eyes of the British authorities. As for an efficiency rating system, it is easy to predict the difficulty that will be experienced in adapting any such scheme to scientific workers; in its report the Joint Commission recognises this fact.

In a detailed criticism of the Reclassification Report

Dr. Edward B. Rosa, of the U.S. Bureau of Standards, lays stress on the departure from established custom which is entailed by the fourth recommendation. He considers that such a system will make the State Service the refuge of the mediocrity, since there is no incentive to the individual worker. He would wish to see initial salaries determined by the promise of the candidate for a class.

The most serious objection which can be raised to the report is the almost complete failure of the Joint Commission to suggest a remedy for a disease which is only too prevalent in the United States Service: the lack of co-ordination and co-operation in research. Before the war each Department was watertight, the idea being to prevent the overlapping of research—which many consider vital to its prosecution—and consequent waste. It is not clear that any particular attention has been paid to this aspect of departmental practice. Above all, it is not evident that the Commission has fully appreciated the possibilities of the co-ordination of research and other scientific Departments of the State.

Efficiency in Industry.

WE referred last week to the comprehensive exhibition at Olympia organised under the auspices of the *Daily Mail* with the object of encouraging modern methods of increasing efficiency by the application of scientific principles. The range covered is large, dealing as it does with education, commercial organisation, factory equipment, and general industrial matters, but the keynote of applying scientific rather than haphazard methods to obtain the improved results now so badly needed runs through it all.

Scientific education is represented on the stand of the University of London, where, among other things, is to be found an interesting display exemplifying the development of the thermionic valve, which is the basis of most modern wireless telegraph work. This goes back to lamps fitted with internal plates by Prof. J. A. Fleming in 1887–89 for the study of the unidirectional conductivity effect discovered by Edison in 1883. Some of the original oscillation valves made as a result of these researches in 1904, and practically used in wireless telegraphy, are also shown. The later developments of the three-electrode valve are exemplified by a large number of valves of different design, including the form to which de Forest gave the name of the "audion." A recent four-electrode valve of Prof. Fleming's own design is to be seen, and the very latest development in wireless telegraphy is exemplified by a large transmitting valve made by the Marconi-Osram Valve Co. Some historic apparatus used by Sir William Ramsay in his researches upon the rare gases is also shown, and a collection of historic electrical apparatus from the laboratories of King's College includes some used by Clerk Maxwell.

Sheffield University shows exhibits relating to the production of cupro-nickel and some special apparatus developed by the department of glass technology. Armstrong College, Newcastle, shows Dr. Bedson's apparatus for the investigation of coal-dust explosions and the inhibitory power of inert dusts. A small amount of the dust mixture to be tested is blown by a puff of air on to a heated platinum wire in a glass bulb, and the sudden rise of pressure due to the little explosion is noted. Another educational exhibit is that of Loughborough College, Leicestershire, which is largely devoted to the work of students of the college. The technical training of partly disabled men occupies a deservedly large section of the exhibition, where the men are seen working at their various trades. An interesting exhibit relating to industrial efficiency is that of Major F. B. Gilbreth, consisting of a working laboratory for the recording of the actual movements of operatives in performing any given operation with the view of determining the most economical and least fatiguing way in which it can be carried out.

Among exhibits in the general engineering section it is interesting to see the Constantinesco wave system of power transmission working rock drills and other appliances on the stand of Messrs. W. H. Dorman and Co., Ltd. Attention should also be directed to an instrument for the regulation of temperature shown by British Oil and Fuel Conservation, Ltd. This is known as the Freeman precision control, and depends on the change of volume of the air in a bulb placed within the furnace or other chamber being heated. The expansion and contraction of the air drive a little column of mercury up and down an inclined tube, causing it to open or close a contact which, by means of a relay arrangement, controls the valve or other device regulating the supply of the heating medium.

Various branches of electrical engineering are represented in the comprehensive exhibit of the British Thomson-Houston Co., Ltd., including an electric welding plant in operation. Particular attention may be directed to a portable Röntgen-ray outfit employing the Coolidge tube with heated cathode. This is arranged to make up into four easily carried packages, and can be erected at the bedside of a patient. It is worked by means of a small transformer, with or without a rotary converter, from any ordinary direct- or alternating-current supply circuit. The power required is about 600 watts. Another remarkable piece of portable apparatus is a wireless receiving set, weighing no more than 20 lb. and needing no external connections, which will pick up messages from the chief Continental stations. A rectifier for charging small batteries from alternating-current circuits, acting on the same principle as the thermionic valve, is also shown.

A representative display of wireless telegraph apparatus is made by the Marconi Wireless Telegraph Co. A complete 3-kw. valve transmitting station for land use is shown, as well as several smaller sizes of valve receiving and transmitting equipments down to a 20-watt portable apparatus, Demonstrations are given by means of the "radio-megaphone," which is a combination of a wireless telephone receiving apparatus and a Creed "stentorphone." This latter in its ordinary form is a loud-speaking gramophone in which the record actuates a valve controlling a flow of compressed air, and gives purer and more powerful sounds than the ordinary gramophone. A large example used in this way is placed in the gallery, where it discourses music, etc., which can be heard all over the building. In the "radio-megaphone," however, the gramophone needle is replaced by a piece of specially designed apparatus which enables the wireless telephone receiver to actuate the control valve. One of these combination instruments on the Marconi stand is used to make audible the time-signals received from the Eiffel Tower and from Nauen, and to reproduce music and speech from a small wireless station at Surbiton. These are picked up on an aerial just outside Olympia.

Messages are also sent periodically from Surbiton in the Morse code at a high speed and are printed in ordinary type automatically on the neighbouring stand of Messrs. Creed and Co., Ltd. The Creed type of printer was recently described in NATURE (December 9, 1920, p. 472). The apparatus here exhibited is of the improved form, in which the use of compressed air is entirely done away with and a revolving type-wheel takes the place of the lever typewriter mechanism of the older apparatus. The main principles of the selecting arrangement whereby the Morse message is translated into type are the same. The new instrument has a working speed of 175 words per minute.

The most complete line telegraph exhibit is that of the Eastern and Associated Telegraph Companies, which includes a complete set of apparatus as used on a long cable circuit. This works with a Creed printer of the older pattern used with the Muirhead type of receiving perforator. Among objects of historical interest is an example of the original form of the Kelvin siphon recorder. Attention may also be directed to examples of different forms of relays used in cable work and an example of an "electrolytic magnifier," which is somewhat similar to a relay except that instead of containing actual contacts that are opened and closed by the galvanometer portion of the apparatus, the moving pointer alters the relative position of wires dipping into an electrolyte, and makes an alteration of resistance which affects the balance of the duplex circuits and actuates the receiving apparatus accordingly.

Recent advances in optical science are exemplified by the exhibits of Messrs. Chance Brothers, Ltd. A special feature is the demonstration of the properties of "Crookes" glass for ophthalmic purposes, which relieves the eyes from strain by absorbing the ultra-violet rays while allowing the whole of the visible spectrum to pass. The company also exhibits for the first time a new "daylight" glass, by the aid of which colours may be matched by artificial light exactly as in daylight. This is a glass of a bluish tint which is accurately balanced in colour against the source of light to be used so as to absorb a selection of the rays and to allow a mixture to pass through which approximates very nearly to daylight. The problem is attacked in a different manner by the Sheringham Daylight, Ltd., who show specially constructed reflecting shades which achieve a similar result by reflection instead of by transmission. In both cases the source of light employed is the half-watt lamp. Another optical instrument which should not be missed is the Optophone, which enables the blind to read from ordinary type. This has already been fully described in NATURE (May 6, 1920, p. 295, and August 5, 1920, p. 722), and is exhibited by Messrs. Barr and Stroud, Ltd.

A very comprehensive example of the methods of modern medical research is presented by the display arranged by the Middlesex Hospital, which includes a large number of prepared sections relating to parasites and bacteria mounted in microscopes. Apparatus is also shown typifying the methods used both for routine and research in photomicrography, Röntgen-ray work, and various branches of biochemical and physiological investigation. St. Mary's Hospital Medical School has also an exhibit relating to the part played by medical research in the promotion of industrial efficiency. Among the subjects illustrated are breathing apparatus for diving, mining rescue work, and gas protection. Apparatus for the recording of muscular effort is also shown.

Human Tails.

AT a meeting of the Royal Anthropological Institute held on February 8, Dr. W. H. R. Rivers, president, in the chair, Prof. Arthur Keith, in making a report on a specimen of a human tail which had been bequeathed to the institute by the late Dr. J. C. McLachan, of Halifax, Yorks, took occasion to review the present state of our knowledge regarding the occurrence of true tails in human beings. The specimen submitted was a true human tail exactly similar to one very completely examined by Prof. Ross Harrison and described by him in the Johns Hopkins Hospital Bulletin of 1901. Prof. Harrison's specimen, which was removed from a boy aged six months, was 40 mm. long at birth, 70 mm. long when excised, contained striped muscle, and moved under various emotional states. Dr. McLachan's specimen was removed from a girl aged three months, measuring 105 mm. long in its preserved state, 11 mm. in diameter at the base, and tapering to a conical point. It also contained strands of striped muscle, and must have had the power of movement. As is the case in all such specimens, with three recorded exceptions, no vertebræ were present, nor could any segmental arrangement be observed in the central core. The skin covering the tail was studded with hair-roots and sebaceous and sweat glands.

Thanks to the labours of Keibel and Elze, and of Prof. Streeter, of the Carnegie Institution, and of his pupils, our knowledge of the development of a true tail in the human embryo may now be regarded as complete. At the end of the fifth week of development, when the human embryo is approaching 5 mm. in length, caudal (post-sacral) segments begin to be differentiated from the tail-bud represented by the growing tip of the tail. By the beginning of the seventh week, when the embryo is about 12 mm. long, the human tail reaches its maximum growth and differentiation, there being then eight to ten caudal segments within the projecting conical tail. In the seventh week retrogression of the terminal and free segments takes place, and towards the end of the eighth week, when the fœtus measures about 25 mm. (1 in.) in length, the surviving four or five basal or coccygeal segments become submerged, drawing with them the terminal atropic segments, the point of disappearance of the terminal atropic part being marked by a dimple. The caudal appendage which occasionally occurs in children represents a persistence of the terminal segmented part of the tail which normally atrophies by the end of the eighth week.

The disappearance of the tail from the body of man is not a human, but a pre-human problem. It is part and parcel of the wider problem of how and when the upright, or, as Prof. Keith would prefer to call it, the orthograde, posture was evolved. The orthograde group of Primates is represented to-day by the gibbon, orang, chimpanzee, gorilla, and man; in all of them the muscles of the spine, and of the thorax and abdomen, and all the spinal and other nerve reflexes which regulate the action of muscles, have been transformed to suit the orthograde posture; in all of them the external tail has disappeared and the basal or pelvic vertebræ of the tail have been reduced to a coccygeal form. The tail is more vestigial in the primitive small-brained gibbon than in man; it is the discovery of a pre-gibbon stock which should give us the history of the disappearance of the human tail, and from the scant data at present available we may infer that such a discovery is likely to be found in strata lying well towards the base of Tertiary deposits.

In pronograde apes, as in four-footed animals, the tail is made up of two parts which are structurally and functionally quite different. The free or terminal part is put to many uses; the pelvic or basal part is always associated with a visceral function. To it the rectum is always attached, and certain muscles which guard the pelvic outlet act upon the pelvic segments of the tail and use it as a perineal shutter. It is the external or post-pelvic segment of the tail which has disappeared from the body of man and the orthograde apes; the pelvic part has survived as the coccyx, and its visceral musculature as the levator ani muscle. With the evolution of the upright posture the pelvic muscles which act on the tail had to bear the steady burden of the abdominal viscera—had to be in action as long as the orthograde posture was maintained. They could not serve in the support of the viscera and the movements of the tail at the same time. Hence only the pelvic part of the tail was retained—the part on which the pelvic musculature acted. In pronograde apes the pelvic visceral musculature is attached to the peculiar chevron-like bones (hæmal arches) placed beneath the pelvic vertebræ of the tail; the reappearance of hæmal arches in the human embryo during the second and third months of development may be regarded as definite proof that man comes of a pronograde ancestry. Tarsius spectrum, for which Prof. Wood-Jones claims a special human relationship, is devoid of all features which mark the orthograde group of Primates; in its tail and tail musculature Tarsius is a pure pronograde Primate.

University and Educational Intelligence.

BIRMINGHAM.—The Doncaster Laboratory for Research in Mining is to be transferred to Birmingham University, under the directorship of Dr. J. S. Haldane, who has accepted the post of honorary professor.

CAMBRIDGE.—The council of St. John's College has appointed Dr. T. J. I'A. Bromwich to be prælector in mathematical science.

An interesting report issued by the Board of Research Studies shows that there are at present in residence seventy-two students admitted as candidates for the Ph.D. degree. The largest number working at any one subject is thirteen for physics. Botany and chemistry with eight each come next, followed by English and history with seven each. Graduates of British universities number thirty-three; sixteen come from Colonial universities, ten from India, and six from the United States.

An analysis of the voting last term on the admission of women as members of the University shows that there was a majority of 33 out of a poll of 405 among the resident teachers in the University in favour of their admission. The University professors also supported the proposal by 27 votes to 15.

Honorary degrees of LL.D. were awarded on Saturday to Sir Patrick Manson, G.C.M.G., and Dr. Albert Calmette, of the Pasteur Institute, Paris. Prof. J. Hjort, the oceanographer and marine biologist, was also given the honorary degree of Sc.D.

Mr. H. G. Carter has been appointed director of the Botanic Gardens.

LONDON.—The Prince of Wales has consented to attend the graduation dinner on the evening of May 5, on the afternoon of which day he will receive the honorary degrees of Master of Commerce and Doctor of Sciences, and will reply to the toast of "The New Graduates." The Guildhall has been kindly placed at the disposal of the University for this purpose by the Lord Mayor and Corporation, and the Lord Mayor has accepted an invitation to be present.

Dr. Anne Louise McIlroy has been appointed to the University chair of obstetrics and gynæcology tenable at the London School of Medicine for Women.

Prof. J. P. Hill has been appointed to the University chair of embryology tenable at University College.

The degree of D.Sc. in botany has been conferred on Miss K. M. Curtis, an internal student of the Imperial College (Royal College of Science), for a thesis entitled "The Life-history and Cytology of *Synchytrium endobioticum* (Schilb.), Perc., the Cause of Wart Disease in Potato."

The Graham Legacy Committee has appointed Mr. V. R. Khanolkar to the Graham scholarship in pathology for two years from April 1, 1921. The value of the scholarship is 400*l.* a year. Since October last Mr. Khanolkar has been assistant bacteriologist in University College Hospital.

IN response to the recent appeal of the University of Edinburgh for 500,000*l.*, the sum of 200,000*l.* has now been subscribed.

MR. W. D. EGGAR will deliver a course of four lectures on Greek mathematics at Gresham College, Basinghall Street, E.C., on Tuesday to Friday, March 1–4, at 6 p.m. Admission will be free.

PROF. E. W. SCRIPTURE, formerly of Yale University, has been appointed to the faculty of the University of Hamburg for the summer semester. He will lecture on English philology and experimental phonetics. Two articles by Prof. Scripture on the nature of vowel sounds appeared in NATURE for January 13 and 20.

AN election of Beit fellows for scientific research is to take place on or about July 15 next, and the latest date upon which applications can be received is April 19. Forms of application and information respecting the fellowships are obtainable by post from the Rector, Imperial College of Science and Technology, South Kensington, S.W.7.

IN connection with the 1920–40 Science Research Fund of Girton College, Cambridge, a fellowship of 300*l.* a year tenable for three years is being offered by the college for research in the mathematical, physical, and natural sciences. Particulars of the fellowship may be obtained from Miss Clover, Coleby, Grange Road, Cambridge, and applications for the fellowship will be received by her not later than March 31 next.

A COURSE of four public lectures on "The History of Plant Delineation" will be given in the lecture-room of the botany department of University College, London, on Wednesdays at 5 p.m., beginning on March 2. Dr. Charles Singer will deal with the art of the ancient empires and of the Dark and Middle Ages, and Dr. Agnes Arber with the period from the invention of printing to modern times. The lectures, which will be illustrated by lantern-slides, are open to the public without fee or ticket.

THE formal opening of l'Institut Français, Cromwell Gardens, S.W., will take place on Saturday, February 26, at 3 o'clock, under the presidency of his Excellency M. le Comte de Saint Aulaire, Ambassador of France. The Minister of Public Instruction, M. Léon Bérard, will represent the French Government. The English Board of Education and the

London County Council will be represented. The Paris Municipal Council and the University of Paris will each send three delegates. Among the latter will be M. Henri Bergson. The rector of the Institut's mother-University of Lille is also expected to be present.

PROF. LUIGI LUIGGI has accepted the invitation of the University of London to deliver a course of six lectures on "Recent Engineering Works in Italy" during his forthcoming visit to England. Dr. Luiggi is the professor of hydraulic engineering in the University of Rome, and also president of the Italian Society of Engineers. The lectures, which have been arranged to be given at the Institution of Civil Engineers at 5.30 p.m. on March 7, 9, 11, 15, 16, and 18, will be open to the public without fee or ticket. They will be illustrated with lantern-slides, which promise to be of particular interest. The chair at the first lecture will be taken by the Italian Ambassador.

THE Council, the Delegacy, and the Professorial Boards of King's College have resolved to found a memorial to the late Dr. R. M. Burrows, who guided the fortunes of the college with such brilliant success during his seven years' tenure of the office of Principal. The memorial will take the form of a tablet to be erected in the college chapel, together with a Ronald Burrows prize, exhibition, or scholarship to be awarded annually to a student of the college who has distinguished himself in the field of Greek studies. Prof. H. G. Atkins has consented to act as honorary treasurer of the memorial fund, and subscriptions may be sent to him at King's College, Strand, W.C.2.

THE annual general meeting of the Association of Technical Institutions will be held at the Grocers' Hall, Princes Street, London, E.C., on Friday and Saturday, March 4 and 5. The president-elect, the Right Hon. Viscount Burnham, will deliver his presidential address, and papers will be read by Principal C. T. Millis on "Junior Technical Schools: Their Status and Position," Dr. W. M. Varley on "The Report of the Departmental Committee on Scholarships and Free Places," Mr. H Stainsby on "Technical Instruction for the Blind," and Principal W. J. Chalk on "Technical Instruction in London of the Higher Branches of Commerce." Important resolutions dealing with the necessity for closer co-operation between the technical colleges and the universities will be submitted for consideration, together with other resolutions on educational matters.

THE annual dinner of the Finsbury Technical College Chemical Society was held on February 18. The president, Mr. A. J. Hale, who occupied the chair, expressed the hope that ultimately the function might develop into a reunion between the past and present chemical students of the college. Mr. J. H. Coste, in proposing the toast of the college, referred to the splendid work which has been done in the past and how every effort was being made by the Finsbury Technical College Defence Committee and by various institutes and societies to prevent the threatened closing of the college. Until the authorities definitely decided to keep the college open, Mr. Coste urged that no effort to gain that end should be relaxed by those interested. This view was warmly supported by Prof. G. T. Morgan. Attention was also directed to the plea for keeping open the college recently made in the columns of NATURE and supported by Sir Oliver Lodge (February 10, p. 757). Mr. C. R. Darling expressed a hope that in the event of the college remaining open its present curriculum would not be altered or its freedom interfered with in any way.

Calendar of Scientific Pioneers.

February 24, 1799. Georg Christoph Lichtenberg died.—The discoverer of the dust figures on electrified planes, Lichtenberg held the chair of physics at Göttingen, and in his day was well known in both Hanover and England.

February 25, 1723. Sir Christopher Wren died.—Before he became famous as an architect, Wren was known as a mathematician. He was one of the founders of the Royal Society, and for twelve years Savilian professor of astronomy at Oxford.

February 26, 1878. Angelo Secchi died.—The successor of the Jesuit father, de Vico, as director of the observatory at the Collegio Romano, Secchi was a pioneer worker in the field of stellar spectroscopy, and his grouping of stellar spectra into types represents one of the results of his extensive studies of this subject.

February 27, 1864. Edward Hitchcock died.—Schoolmaster, minister, and, lastly, professor of chemistry and natural history at Amherst College, Hitchcock suggested and carried out the geological survey of Massachusetts. He is recognised as one of the fathers of American geology.

February 27, 1906. Samuel Pierpoint Langley died.—The great pioneer of aviation, Langley was originally a civil engineer, but abandoned that profession for astronomy. For the study of the infra-red portion of the solar spectrum, in 1880 he devised the spectro-bolometer—an electrical resistance thermometer of extreme delicacy. In 1887 he became secretary to the Smithsonian Institution. Taking up the investigation of the resistance offered to planes moving through the air, he was led to the construction of the steam-driven model flying machine which in 1896 made successful flights of half a mile. Having thus demonstrated the practicability of mechanical flight, he left the commercial and practical development of the idea to others.

February 28, 1882. Thomas Romney Robinson died.—An Irish clergyman, Robinson for many years directed the Armagh Observatory. He was also a physicist, and in 1843 invented the well-known cup anemometer.

February 29, 1744. John Theophilus Desaguliers died.—Like Dollond, Demoivre, Demainbray, and others, Desaguliers was of Huguenot extraction. Educated at Oxford, for many years he lectured there and in London, and rendered notable services to science when some acquaintance with scientific principles was first considered fashionable. He was the second recipient of the Copley prize.

March 1, 1862. Peter Barlow died.—Professor of mathematics at Woolwich, Barlow was a pioneer in the study of the strength of materials, and did much important work in terrestrial magnetism.

March 2, 1840. Heinrich Wilhelm Mathias Olbers died.—A doctor at Bremen, Olbers, by limiting his sleep to four hours nightly, accomplished much astronomical work, and was the discoverer of the minor planets Pallas and Vesta.

March 2, 1911. Jacobus Henricus van't Hoff died.—A student under Kekulé and Wurtz, van't Hoff became a professor at Amsterdam, and in 1896 professor of chemistry to the Prussian Academy of Sciences. A great physical chemist, he developed the theory of solutions, and was one of the founders of stereochemistry. With Le Bel in 1893 he was awarded the Davy medal, and in 1901 he received the Nobel prize.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, February 3.—Prof. C. S. Sherrington, president, in the chair.—Dr. G. B. **Jeffery**: The field of an electron on Einstein's theory of gravitation. Equations are obtained for the motion of a single electron about an atomic nucleus. If a ray of light passes through the field of the electron, provided that the distance of closest approach is not too small, the ray is deflected towards the electron. For closer approach the sense of the deflection is reversed until in the limit the ray is reflected back again along its original path. These results are used to ascertain whether any possible electric field of the sun would produce a measurable effect on the crucial phenomena of Einstein's theory. It is found that, while the sun's electric field would tend to diminish the displacement of the spectrum lines, the field required to produce compensation is of the order of 10^{13} volts per cm. at the sun's surface.—Dr. M. N. **Saha**: A physical theory of stellar spectra. Elsewhere a theory of thermal ionisation (and partly of thermal radiation) of gaseous elements has been developed and applied to the explanation of the ionisation observed in the solar chromosphere, and the absence of certain elements from the Fraunhofer spectrum. In the present paper the theory has been extended towards a physical explanation of the ordered gradation in the spectra of stars. The stellar data, particularly those accumulated by the Harvard College Observatory, are discussed from the point of view of the present theory, and it has been shown that the varying spectra of stars can be explained as functions of a single physical variable, viz. the temperature of the stellar atmosphere.—W. F. **Darke**, J. W. **McBain**, and C. S. **Salmon**: The ultra-microscopic structure of soaps. The ultra-microscopic observations of Zsigmondy and Bachmann on soap-curds have been confirmed, interpreted, and extended. The kinematograph has been employed as an aid in elucidating the formation and disappearance of the various structures observed. The curds of sodium, potassium, and hydrogen soaps are described and discussed.—Dr. J. **Mercer**: Linear transformations and functions of positive type. The paper contains developments of the theory of linear functional transformations as developed by F. Riesz in his paper "Untersuchungen über Systeme integrierbaur Funktionen" (*Math. Annalen*, vol. lxix., pp. 449–97).

Mineralogical Society, January 18.—Mr. A. Hutchinson, vice-president, in the chair.—A. F. **Hallimond**: The olivine group. Since the discussion of the densities by Thaddéef in 1896, and of the optical constants by Backlund in 1909, numerous additions have been made to the published data. These have been collected and the most probable values for the pure compounds obtained. The molecular volume of monticellite is slightly greater than the mean between forsterite and $\gamma-Ca_2SiO_4$. For the complex mixtures the density and mean refractive index yield additive relationships, but the birefringence and axial ratios follow no additive law. The conditions of plotting which must be observed if the variation of an additive property with composition is to be expressed by a straight line were briefly summarised.—W. A. **Richardson**: A method of rock-analysis diagrams based on statistics. Oxide variation diagrams, similar to those employed by Dr. Harker, can be used for expressing the chemical relations of rock groups and individuals. The diagrams obtained from plotting Iddings's selected analyses gave the maximum variation for all rocks.—L. J. **Spencer**: Identity of Trechmann's "β-tin" with stannous sulphide. A re-examination of the original material described by C. O. Trechmann in 1879 as an orthorhombic modification of tin proved that he made his crystallographic determinations on crystals of one kind (viz. stannous sulphide), whilst the chemical analysis was made on crystals of another kind (viz. metallic tin). Tin is, therefore, dimorphous and not trimorphous, "white tin" being tetragonal and "grey tin" cubic. Orthorhombic crystals of stannous sulphide (SnS) and tetragonal crystals of iron stannide ($FeSn_2$) from tin furnaces and rhombohedral crystals of tin arsenide (Sn_3As_2) isolated from a tin-arsenic alloy were described.

Linnean Society, January 20.—Dr. A. Smith Woodward, president, in the chair.—E. H. C. **Walsh**: Lhasa and Central Tibet. The lecturer gave first a brief description of the country, the people, the religion, and the government. The country extends 1600 miles in its greatest breadth, and 800 miles in its greatest width, from the Koko Nor to the southern bend of the Takiang or Blue River; the superficial area is more than a million square miles, comprises the highest portion of the earth's surface, and is bounded on its southern frontier by the Himalayas, the loftiest chain of mountains in the world. The Tibetans are a Turco-Mongolian race and speak a monosyllabic language; it is believed that they originally lived in China, but were driven out by conquering races. They are mentioned as early as 770 B.C., when they were at war with the Chinese. There are two acknowledged forms of religion, the Buddhist and the Bon, pronounced Pön; the latter has adopted some of the formulas of the former, but reversed them, as in the case of the "Swastika" or fyle-fot cross; also the Buddhist prayer-wheel, with its invocation "Om mani padme hum." The two sects lived peaceably side by side. The Dalai Lama, the Pope of the Lamaïst Church, is believed to be a continuous incarnation of previous Dalai Lamas, and of the Deity Avalokiteswara upon earth. When a Dalai Lama dies his reincarnation has to be looked for in some infant born shortly afterwards, and this is ascertained by the chief oracle indicating the part of the country and some clues, and the result of local inquiries is then reported to the leading Lamas, who decide by lot the actual child to be educated as the Dalai Lama.

Physical Society, January 28.—Sir W. H. Bragg, president, in the chair.—Prof. H. **Nagaoka**: The magnetic separation of neon lines and Runge's rule. The results of an investigation of the Zeeman effect for neon lines are given. The departures from Runge's rule—that the magnetic separation of the lines are aliquot parts of the separation of the normal triplet—are discussed. It is concluded that such discrepancies are due to variations of the ratio e/m.—E. V. **Appleton**: A method of demonstrating the retroactive property of a triode oscillator. The author, following Vallauri, gives an approximate treatment of the conditions which give rise to retro-action between the grid and anode circuits of a triode valve, and describes an arrangement of circuits whereby the property can easily be demonstrated to a large audience.—Dr. D. **Owen** and R. M. **Archer**: The quickness of response of current to voltage in a thermionic tube. Steady voltages were applied between the hot and cold electrodes of a thermionic tube for intervals of time varying from 0·00001 second to a minute or longer. The mean current during the interval was measured by the Wheatstone bridge, using a null ballistic method. Two types of thermionic tube were employed, one at a high gas pressure and the other at a higher degree of exhaustion. The initial rise of current to its maximum is followed by a fall, the rate of which diminishes with time. In the tube at the high gas pressure the final value of current may be less than half the initial value. In the case of the tubes at lower gas pressure the fall is less pronounced, say 3 or 4 per cent. This fall is not attributable merely to the high temperature of the filament, but is conditional on the thermionic current being permitted to flow.

Linnean Society, February 3.—Dr. A. Smith Woodward, president, in the chair.—M. **Christy**: Wistman's Wood. Wistman's Wood is a small grove of ancient, but exceedingly gnarled and diminutive, oak-trees (*Quercus pedunculata*) growing out of an extensive pile of huge angular blocks of granite (known as a "clatter") without a particle of visible soil. The wood is almost in the centre of Dartmoor at an elevation of about 1500 ft. It contains about 300 to 400 trees, which are overgrown by masses of moss and lichens. Particulars of the habit and age of the trees are given.—Dr. Agnes **Arber**: The leaf-tips of certain Monocotyledons. The leaves of Monocotyledons are studied from the point of view of the phyllode theory. In simple monocotyledonous foliage leaves terminating in a solid apex, and also in spathe leaves ending in a similar tip, the main part of the leaf is of leaf-sheath nature, while the apex represents a vestigial petiole. In complex monocotyledonous leaves which are differentiated into sheath, stalk, and "blade," certain cases are known in which the "blade" terminates in a solid apex. It is provisionally suggested that such apices represent the unexpanded tip of the petiole.—T. A. **Dymes**: Seeding and germination of *Ruscus aculeatus*, Linn., in the south-eastern quarter of England. The berries and seedlings perish by severe frost, although the adult is hardy. Many seeds fail to germinate because immature. Frost kills many seedlings during the first winter. Better results are obtained by sowing, as soon as the seeds are ripe, at a depth of 1 in. than at a greater depth or in the spring. Survivors in the second season produce an axis some 3 in. long, bearing about six phylloclades in the axils of scale-leaves. The radicle perishes and adventitious roots are produced. During the second winter the seedlings are unable to withstand severe frost. There is no recapitulation of the ancestry by the seedling.

Aristotelian Society, February 7.—Lord Haldane, vice-president, in the chair.—Prof. R. F. A. **Hoernle**: A plea for a phenomenology of meaning. The task of a phenomenology of meaning is to collect and examine all types of empirical situations in which signs function and meaning is present. This is the more necessary as all the higher activities and all control of social organisations depend on the use of signs. Yet current theories are fragmentary and one-sided. This is shown by an examination of the theories of F. C. S. Schiller, B. Russell, Lady Welby, C. S. Peirce, G. F. Stout, A. Meinong, and E. Husserl. A clue to a completer theory may perhaps be found in the distinction between the *indicative* and the *expressive* function of signs. We have the pure indicative function when the existence of A enables us to infer the existence (or non-existence) of B. We have the pure expressive function when an agent makes or utters signs. The two functions are curiously interlaced in intersubjective intercourse. The distinction, however, requires to be tested further by application to various kinds of non-verbal signs, to symbolic actions, and especially to the functions of sounds in music.

CAMBRIDGE.

Philosophical Society, January 24.—Prof. Seward, president, in the chair.—G. I. **Taylor**: (1) Experiments with rotating fluids. A summary of results on three subjects connected with the dynamics of rotating fluids was given without proof. The subjects treated were (*a*) difference between two- and three-dimensional motion, (*b*) stability of fluid contained between two cylinders, and (*c*) motion of a sphere in a rotating fluid. Experiments were described, and in the case of (*a*) and (*c*) some were shown at the meeting. (2) Tides in the Bristol Channel. It is shown that the Bristol Channel, which contains some of the largest tides in the world, can be represented with considerable accuracy by a channel the breadth and depth of which vary uniformly from the mouth to the head. Calculations of the effect of such a channel in increasing the tides are shown to agree well with the observed tides in the Bristol Channel. It appears, therefore, from the results obtained that the usual hydrodynamical theory of tides accounts quantitatively as well as qualitatively for the abnormally high tides which exist at the head of the Bristol Channel.—F. W. **Aston**: The deterioration of fabric under the action of light, and its physical explanation. The only serious factor in deterioration of unprotected aeroplane fabric, doped or undoped, when exposed to weather is found to be the action of sunlight. On investigation this action is shown to be relegated to the ultra-violet part of the spectrum. This deterioration appears to be due to the formation of ozone from the oxygen of the air which acts upon the fibres. This explanation is upheld by the fact that if the fabric is kept in a vacuum or in an atmosphere of hydrogen the effect is enormously reduced. Normally, ozone is formed in oxygen only by the action of light of wave-length too short to occur in sunlight at all, but this difficulty has been removed by Prof. Lindemann, who shows that the high refractive index of the fibres modifies the photo-electric action, increasing the maximum effective wave-length by a factor which brings the value up to that actually determined by experiment.—S. **Lees**: Note on constant-volume explosion experiments. An attempt is made to compute the order of the effect of temperature variations in an explosion vessel on the values of the total internal energy measured. The author gives reasons which indicate that the experimentally determined values of internal energy so obtained ought to be reduced slightly to get the corrected values for uniform temperatures. The correction is probably less than 1 per cent. for air at 1600° C. This correction is probably within the limits of experimental error at the present time.—V. **Brun**: The function $[x]$.

MANCHESTER.

Literary and Philosophical Society, November 30.—Sir Henry A. Miers, president, in the chair.—Prof. T. G. B. **Osborn**: Notes on stone implements from the Cooper's Creek District, South Australia. Most of the specimens were found in May last on old camping-grounds of the Deari tribe during a visit to Killalpannina, on the Barcoo (Cooper's Creek), in the Lake Eyre region. It seems probable that knives were manufactured in certain places and the finished articles carried away. A crude flake struck off at a single blow served as a temporary cutting instrument provided it had a sharp edge, and was then discarded. Scrapers, knives, flakes, hammer-stones, and stones for grinding and crushing food materials were found. The grinding stones were used for grinding small seeds of *Eucalyptus microtheca*, etc.; the crushing stones for breaking hard "beans" of "nardoo" (sporocarps of Marsilea sp.).—Prof. A. V. **Hill**: The purpose of physiology. As the handmaid of medicine, the task of physiology lies in the discovery and statement of the "normal" as distinguished from the "abnormal." As a pure science it is privileged to explore the mechanisms underlying the phenomena of life by any and every means provided by scientific progress. As an applied science, in co-operation with psychology, it deals with such questions as the conditions of maintenance of the "normal," the standards of fitness, mental, moral, and physical, and the biological factors in the economic or social system. Progress may be expected in the regions where physiology verges on the other, especially on the exact, sciences, while the stimulus to the applications of physiology appears on the borders of medicine, sport and physical training, industrial fatigue, sociology or economics.

December 9.—Mr. R. L. Taylor, vice-president, in the chair.—Prof. T. E. **Peet**: Ancient Egyptian mathematics. Known to us chiefly from the Rhind papyrus in the British Museum, Egyptian mathematics is not a speculative science, but one purely practical in scope. The author dealt with the cumbrous notation; the use only of fractions the numerator of which was unity (with the one exception of two-thirds); tables for multiplication by 2 only, and with division by 2 only, larger divisions being done by trial. Problems such as the division of food, the measurement of areas, the exchange of loaves of various sizes and of jugs of beer were easily accomplished. A parallelopiped was correctly cubed, the volume of a cylinder obtained, and the circle given as the square of eight-ninths of its diameter. The existence in Egypt of a standard of rings or *shatyw* of various metals was dealt with.

Dublin.

Royal Dublin Society, January 25.—Dr. F. E. Hackett in the chair.—J. J. **Dowling**: A direct-reading ultra-micrometer. The apparatus, which was exhibited in operation, depends on the variation of the plate current in an oscillating-valve circuit, which accompanies a variation in the capacity of the oscillating circuit. The sensitivity of the arrangement is very high, but even under unfavourable conditions it shows remarkable steadiness. Preliminary measurements show that a displacement of about 2×10^{-8} cm. is detectable under ordinary working conditions, and with suitable precautions very much greater sensitivity can be reached. Further work in connection with the apparatus is being carried out.—J. **Reilly** and W. J. **Hickinbottom**: The distillation constant of certain primary alcohols. The authors have applied their method of distillation in steam to methyl, ethyl, propyl, butyl, and *iso*amyl alcohols. Percentage of alcohol is estimated from density or by oxidation. Distillation constant varied with concentration.

Edinburgh.

Royal Society, January 10.—Prof. F. O. Bower, president, in the chair.—The late Dr. John **Aitken**: Thermometer screens. This paper was left in manuscript by Dr. Aitken, and was completed a few days before his death. It gives a new series of experiments summing up his results communicated from time to time during the last thirty years. The points emphasised were (1) the inadequacy of the Stevenson screen, which in sunny weather always makes the enclosed thermometers read too high; (2) the uncertainty of measuring the temperature of the air, which cannot be other than a time-average varying with the thermometer used; and (3) the description of a new simple form of screen which satisfies all practical needs.—Prof. W. **Peddie**: The avoidance of relativity which is not of Galileo-Newtonian type. It is the aim of natural philosophy to find more and more inclusive laws describing the course of inanimate Nature. Examples are the conservation of matter and energy, the law of least time, stationary action, varying action, and Einstein's recent development of relativity. Their chief value lies in the fact that they give results which are independent of the particular mechanism involved. All actions which seem to occur at a distance take place, according to Newton, through a medium or æther. It is sometimes asserted that in consequence of the results of the principle of relativity the æther is non-existent; but the natural philosopher is entitled to claim that any such deduction from a theory which obtains its results independently of the mechanism involved can have no validity. Within its range the principle is of great value and constitutes the greatest advance made in connection with general laws since the introduction of the principles of action. These general laws can only be judged by the coincidence of their conclusions with observation. In this respect Einstein's principle stood successfully the test of two facts of observation, one of which was a prediction. In connection with a third the result is doubtful. It is, therefore, desirable to consider possible modifications of the basis to which the principle is applied. The only one now possible seems to be that connected with the postulate that light is propagated through a uniform æther regarded as at rest in space. If light is propagated through æthereal strain-forms associated with the atoms and moving with them, the æther itself may be at rest, but this experimental foundation for the recent extensions of relativity would disappear. On the other hand, in this case a positive result should be given by the Michelson-Morley experiment if made with light from a star moving rapidly to or from the earth. The paper concluded with a discussion of the possibility of a mechanical foundation of this view in an extension of Osborne Reynolds's theory of a granular æther.—F. **Unwin**: The transverse galvanomagnetic and thermomagnetic effects in several metals. This investigation into these minute effects gave results which were compared with certain conclusions derived by Livens from the modern electron theory. The agreement was satisfactory as regards the ratios of the effects, but not as regards their magnitudes.—P. **Humbert**: The confluent hypergeometrical functions of two variables.

Paris.

Academy of Sciences, January 31.—M. Georges Lemoine in the chair.—The president announced the death of M. Emile Bourquelot, member of the section of chemistry.—L. **Favé**: Curves designed for the determination of orthodrome routes. On a sheet of transparent material curves are drawn representing, in Mercator's projection, a series of great circles cutting the equator at the extremities of a given diameter. A second family of curves of a different colour serve to measure the orthodrome distance.—A. P. **Dangeard**: Observations of an alga cultivated in the dark for eight years. *Scenedesmus acutus* has been cultivated in the absence of light since January, 1913, and is as green as specimens grown in the light in the ordinary way. The examination of the absorption spectrum of the chlorophyll shows no difference between the two series. A special culture medium is required, the composition of which is given.—E. **Mathias**, C. A. **Crommelin**, and H. K. **Onnes**: The rectilinear diameter of hydrogen. Supplementing earlier work, the densities of liquid hydrogen between $-239.91°$ C. and the boiling point, $-252.76°$ C., have been studied. The cryostat used consisted in a bath of superheated hydrogen vapour, obtained from the evaporation of the liquefied gas and heated by electrical means. The automatic current regulator employed permitted control of the temperature to within 0·01° C. for several hours. The experiments required the preparation of about 170 litres of liquid hydrogen and 400 litres of liquid air. The ordinate of the diameter was found to be $-0.06351-0.00039402\,\theta$. The critical density was 0·03 and the critical coefficient 3·276. Hydrogen obeys the law of the rectilinear diameter.—Auguste Béhal was elected a member of the section of chemistry in succession to the late Armand Gautier.—G. **Fubini**: Automorphic functions.—T. **Varopoulos**: A class of multiform functions.—A. **Véronnet**: The variation of a conical trajectory under the action of the resistance of a medium.—J. **Villey**: Experimental installations for aerodynamical researches. A discussion of the recent proposal by M. Margoulis, suggesting the use of carbon dioxide under high pressures and at low temperatures as the circulating gas in the testing of aeroplane models. Apart from certain difficulties of construction which would add to the cost of the apparatus, the author is of opinion that the use of carbon dioxide could only be complementary to the use of air, and could not safely be employed instead of the latter.—M. **Curie**: The action of red and infra-red rays on phosphorescent substances. An account of experiments in which zinc sulphide and other phosphorescent substances were submitted to the simultaneous action of ultra-violet rays (mercury lamp with nickel oxide glass filter) and infra-red rays (arc lamp with cuprous oxide glass filter). The sulphides examined behaved differently from fluorescent bodies such as uranium nitrate, barium platinocyanide, and fluorescein.—M. **de Broglie**: The corpuscular spectra of the elements.—A. **Léauté**: Complement to the theory of the induced reaction for saturated alternators.—H. **Colin** and Mlle. A. **Chaudun**: The application of the law of hydrolysis to the determination of molecular weights.—A. **Mailhe**: The catalytic preparation of secondary amines and an attempt to introduce the alkyl group into these bases. Schiff's bases, mixed with a small quantity of finely divided nickel and heated to 170° C., are reduced smoothly to secondary amines by hydrogen. An attempt to prepare tertiary amines by passing a mixture of the secondary amine and alcohol over alumina heated to 380°–400° C. was not successful, as the bases were split up in contact with the catalyst.—E. **Saillard**: The balance of chlorine during the manufacture of sugar and the proportion of chlorine in the beetroot.—L. **MacAuliffe** and A. **Marie**: The study and mensuration of 117 Belgians.—P. **Audigé**: The growth of fishes maintained in a medium at a constant temperature.—E. **Rabaud**: The paralysing instinct of the spiders.—R. **Bayeux**: Respiratory insufficiency at very high altitude and its correction by subcutaneous injections of oxygen.—A. **Lumière** and H. **Couturier**: The nature of the anaphylactic shock. Further experiments tending to show that the causes of the anaphylactic shock are the same as those of the anaphylactoid crises resulting from the sudden introduction of insoluble substances into the circulation.—Et. and Ed. **Sergent**: Attempts at vaccinating against paludism in birds due to *Plasmodium relictum*.—E. **Woolman**: The *rôle* of flies in the transport of pathogenic germs studied by the technique of aseptic cultivations. These experiments show that contaminated flies remain infected for some days only. Removed from the source of contamination, they free themselves very rapidly, probably mechanically, from the infecting germs.—MM. **Kohn-Abrest**, **Sicard**, and **Paraf**.

MELBOURNE.

Royal Society of Victoria, November.—Mr. F. Wisewould, vice-president, in the chair.—E. **Ashby**: A description of the Bracebridge Wilson collection of Victorian Chitons, with a description of a new species from New Zealand. This collection was made by the late Mr. J. Bracebridge Wilson, working in connection with the Port Phillip Exploration Committee of the Royal Society, and was dealt with by E. R. Sykes in the Proc. Malac. Soc. in 1896. In addition to the five species described by Sykes as new, the author notes four other species then undescribed, *Callochiton rufus*, Ashby, which has hitherto been known only by a single type-specimen dredged in South Australia, and a new species of Lepidopleurus from New Zealand.—Dr. J. M. **Baldwin**: Application of genetics to plant-breeding. The problems of genetics are those which grow out of a study of the resemblances and differences in individuals related by descent. There are four general lines of attacking the problems: (*a*) The method of observation used by Darwin in marshalling evidence in favour of the evolution theory; (*b*) biometrical methods employed with such success by Pearson; (*c*) cytological methods, which are primarily concerned with a study of cell-mechanism; and (*d*) experimental breeding, which involves the raising of pedigreed cultures of plants. From the last method have come many stimulating ideas of heredity and variation, including the Mendelian theory of heredity, the pure-line theory of Johannsen, and the mutation theory of De Vries.

Books Received.

Journal of the Royal Statistical Society. New Series. Vol. lxxxiv., part 1, January. Pp. x+165. (London.) 7*s*. 6*d*.

A New Bristol Flora: British Wild Flowers in their Natural Haunts. By A. R. Horwood. (In 6 vols.) Vol. i. Pp. ix+244. Vol. ii. Pp. xi+243+xvii plates. (London: Gresham Publishing Co.) 12*s*. 6*d*. net per vol.

Principles of Human Geography. By E. Huntington and S. W. Cushing. Pp. xiv+430. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 21*s*. net.

Rapid Methods for the Chemical Analysis of Special Steels, Steel-making Alloys, their Ores and Graphites. By C. M. Johnson. Third edition, revised and enlarged. Pp. xi+552. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 36*s*. net.

The Health of the Industrial Worker. By Prof. E. L. Collis and M. Greenwood. Pp. xix+450. (London: J. and A. Churchill.) 30*s*. net.

Poverty and its Vicious Circles. By Dr. J. B. Hurry. Second and enlarged edition. Pp. xvi+411. (London: J. and A. Churchill.) 15*s*. net.

The Mother and the Infant. By Edith V. Eckhard. (Social Service Library.) Pp. viii+256. (London: G. Bell and Sons, Ltd.) 6*s*. net.

The Microscope: Its Design, Construction, and Applications. Edited by F. S. Spiers. Pp. v+260+plates. (London: C. Griffin and Co., Ltd.) 21*s*. net.

Il Regime delle Acque nel Diritto Publico e Privato Italiano. By A. Vitale. Pp. x+480. (Milano: U. Hoepli.) 25 lire.

Diary of Societies.

THURSDAY, FEBRUARY 24.

MEDICO-PSYCHOLOGICAL ASSOCIATION OF GREAT BRITAIN AND IRELAND (at 11 Chandos Street, W.1), at 2.45.—Sir Frederick Mott and Dr. Hayne: The Pathology of Dementia Præcox, especially in Relation to the Condition of the Ovaries.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—F. Balfour Browne: Mason Bees and Wasps.

ROYAL SOCIETY, at 4.30.—Sir Ray Lankester: A Remarkable Flint-implement from Selsey Bill.—Dr. E. J. Allen: Regeneration and Reproduction of the Syllid Procerastea.—E. C. Grey and E. G. Young: The Enzymes of *B. coli communis*. Part II. (*a*) Anaerobic Growth followed by Anaerobic and Aerobic Fermentation. (*b*) The Effects of Aeration during the Fermentation.—Dr. A. E. Everest and A. J. Hall: Anthocyanins and Anthocyanidins.

ROYAL SOCIETY OF MEDICINE (Tropical Medicine Section), at 5.—Sir Leonard Rogers: Presidential Address.—Dr. J. G. Thomson and Dr. A. Robertson: The Value of Laboratory Reports in the Diagnosis of Suspected Dysentery, and their Interpretation by the Clinician.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. Martin Flack: Respiratory Efficiency in Relation to Health and Disease (Milroy Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Prof. E. Wilson: Magnetic Susceptibility of Low Order. II. Susceptibility Values.

CONCRETE INSTITUTE, at 7.30.—E. S. Andrews: Methods of Securing Impermeability in Concrete.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—Discussion: The Use of Light as an Aid to Publicity.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.

FRIDAY, FEBRUARY 25.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 4.30.—Sir Humphry Rolleston and Others: Discussion on The Diagnosis and Treatment of Congenital Syphilis and its Effects.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—T. Smith: Tracing Rays through an Optical System.—J. Guild: The Refractometry of Prisms.—R. H. Humphry: A Note on the Hot-Wire Inclinometer.—Profs. E. Wilson and E. F. Herroun: The Magnetic Susceptibility of Certain Natural and Artificial Oxides.

TECHNICAL INSPECTION ASSOCIATION (at Royal Society of Arts), at 7.30.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—H. T. Davidge: Measurements of Precision in Engineering.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.30.—Dr. R. M. F. Picken: The Epidemiology of Measles in a Rural and Residential Area.

SATURDAY, FEBRUARY 26.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. Fowler: Spectroscopy (Celestial Spectroscopy).

MONDAY, FEBRUARY 28.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Discussion of Professional Questions.

ROYAL SOCIETY OF ARTS, at 8.—Dr. E. K. Rideal: Applications of Catalysis to Industrial Chemistry: Hydrolytic Processes (Cantor Lecture).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—W. W. James: Some Clinical Cases Associated with Dental Infection.—P. Cole: Condition of Two Pedicle Bone Grafts two years after Operation.

MEDICAL SOCIETY OF LONDON (at 11 Chandos Street, W.1), at 8.30.—Dr. J. H. Ryffel and Others: The Chemical Estimation of Gastric Function.

TUESDAY, MARCH 1.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. Keith: Darwin's Theory of Man's Origin in the Light of Present-Day Evidence.

INSTITUTE OF CHEMISTRY (Annual General Meeting), at 4.30.—Sir Herbert Jackson: Presidential Address.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. G. Graham: Glycæmia and Glycosuria (Goulstonian Lecture).

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. D. Johnston: A Plain Traveller's Tale, Rome to Naples.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Jay Hambidge: Further Evidence for Dynamic Symmetry in Ancient Architecture.

WEDNESDAY, MARCH 2.

NEWCOMEN SOCIETY (at Marconi House), at 5.—L. St. L. Pendred: Trevithick's London Locomotive of 1808.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—C. Ainsworth Mitchell: The Acidity of Ink and the Action of Bottle Glass on Ink.—G. Van B. Gilmour: The Detection of Adulteration in Butter by Means of the Melting-Point of the Insoluble Volatile Acids.—S. H. Blichfeldt and T. Thornley: Method and Apparatus for Routine Determination of Melting-Points of Fats and Fatty Acids.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—E. Warren: Architectural Impressions of a Recent Tour in Mesopotamia.

ROYAL SOCIETY OF ARTS, at 8.0.—Capt. J. M. Hollis: The Reeducation of the Disabled.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.—Dr. W. H. Hatfield: Automobile Steels.

THURSDAY, MARCH 3.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—F. Balfour Browne: Mason Wasps.

ROYAL SOCIETY, at 4.30.—Discussion on Isotopes to be opened by Sir J. J. Thomson, followed probably by F. W. Aston, Prof. F. Soddy, Prof. T. R. Merton, and Prof. F. A. Lindemann.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.—J. W. W. Dyer: Airship Fabrics.—Major T. Orde Lees: Parachutes.

LINNEAN SOCIETY, at 5.—R. T. Günther: A Manuscript of Matthias de Lobel, from the Library of Magdalen College, Oxford.—Dr. B. Daydon Jackson: Naturalists and their Indebtedness to the National Trust.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. G. Graham: Glycæmia and Glycosuria (Goulstonian Lecture).

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Miss M. C. Buysman: The Value of the Drama in the Training of the Child's Emotions.

CHEMICAL SOCIETY, at 8.

FRIDAY, MARCH 4.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—Problems of Seismology: opened by Prof. H. Lamb, followed by Dr. G. W. Walker, R. D. Oldham, and J. J. Shaw. Chairman: Prof. H. H. Turner.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at Faraday House), at 6.30.—A. Rosen: Telephonic Transmission through Submarine Cables.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—W. A. Tait: Severn Crossings and Tidal Power.

SATURDAY, MARCH 5.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Electricity and Matter.

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